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FUNCTIONAL PLANT LAYOUT INCREASES PRODUCTIVITY

By **JAMES D. RENOLLET,** *Owner and Manager*
Franklin Steel Treating Company
Columbus, Ohio

COMMERCIAL heat treating plants provide the highly specialized service of processing an endless diversity of metal parts sent to them by almost an equal variety of customers. The eternal question, re-echoed on the profit or loss statement of practically every such "job shop" operation, bluntly seeks an answer to the vital problem of maintaining a maximum flow of work in and out of the plant.

How to produce quality work economically and at the same time pass along savings to the customer . . . how to meet the demand for faster service . . . how to exist in the highly competitive heat treating field and still realize a reasonable return on the capital investment . . . such are the tribulations that challenge today's commercial heat treaters.

Fig. 1—Lift truck delivers a load of parts to be salt treated. One operator (left) is removing marquenched work from the martempering bath while another operator is loading work in one of the two cyaniding furnaces.

Franklin Steel Treating Company found an answer to these problems when they built their plant in Columbus, Ohio. An inexpensive but substantial building with minimum partitions provided sufficient room for a well-planned layout of equipment. Furnaces were grouped in areas by type of primary operations to be performed, each having storage space for in-process work. At the time of plant layout, furnaces were so grouped that secondary operations were close to the primary operations. All work is moved on skids by lift truck. A plan whereby 80% of all furnaces were purchased from the same manufacturer, simplified maintenance, service and finance factors.

In every instance, standard-rated equipment was purchased thus creating a number of advantages. First, knowing the rated production and fuel capacity; secondly, achieving lower cost because the furnace did not have to be specially engineered; and thirdly, the equipment was standardized, assuring lower future cost of maintenance and replacement parts.

Adequate heat treating capacity was provided by using relatively smaller units, duplicated, rather than single large units of equal capacity. This also provided more versatility in production of different heat treating processes.

Building Separated Into Three Sections

The building is of concrete block construction 125 feet long by 75 feet wide. It is divided into three general sections. The front section houses the shop office, supplies and maintenance departments, and a shipping and receiving dock. The business and executive offices are on the second floor. The center section provides the space for general storage, inspection, salt bath operations and oven furnace work such as annealing, carburizing and normalizing. In the rear section are located atmosphere heat treating, induction, tempering and straightening units.

Standardized Equipment

All major furnace equipment was purchased from Surface Combustion Corporation, Toledo, Ohio. This effected considerable savings in the cost of the original equipment.

The equipment includes four standard-rated salt bath furnaces; two standard-rated large oven conjecto-fired furnaces; two horizontal alloy muffle atmosphere furnaces; and one convection tempering furnace. There also is an induction heating unit built by Allis Chalmers.

Salt Bath Versatility

The four salt bath furnaces form a tight line along the west wall of the building. These occupy floor space 40 by 10 feet. Two 20" diameter by 20" deep pots are used for liquid carburizing, cyaniding and reheating. One 22" diameter by 30" deep pot is used for neutral or draw salt as required. A rectangular pot 20" wide, 30" long and 36" deep is used in combination with the neutral salt pot to form an isothermal heat treating setup. This group of furnaces is used for a large variety

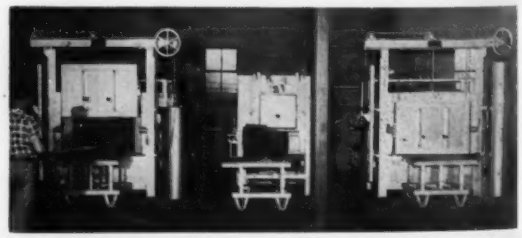

Fig. 2—Pack carburized work is being removed from a large oven furnace. Work is moved on elevated skids by lift truck.

of jobs where quantities are small or where differential hardening is necessary, or where low carbon steels or parts must be heated and quenched vertically. Much of the work that is pack carburized is later reheated and quenched out of the salt bath furnaces. (See Fig. 1).

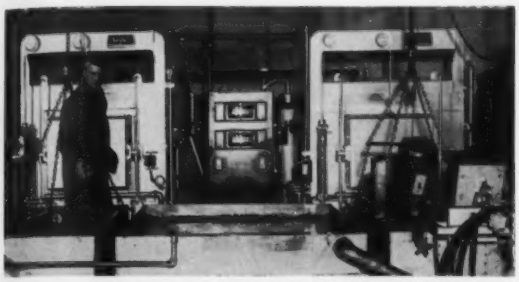

Fig. 3—Two horizontal muffle units are used for controlled atmosphere heat treating. A MRX gas generator is located between and behind the furnaces. Compact installation of furnaces, instrument and quench tanks promotes efficiency. One man operates this group of furnaces.

Oven Type Furnaces

The two Surface conjecto-fired large oven furnaces are the work horses in this plant. Operating from 600°F. to 1850°F., the furnaces are used for stress relieving, pack carburizing, annealing (regular and box) and normalizing. These furnaces combine ruggedness with trouble-free operation because of simplicity of design. The feature of conjecto firing for fast and uniform heating over the whole working range makes these furnaces vital to this commercial heat treating operation. These furnaces have a hearth dimension 42" x 84" x 21" high. (See Fig. 2).

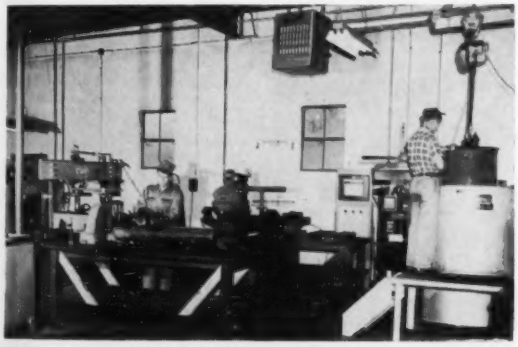

Fig. 4—The convection draw furnace is located near straightening and testing equipment, thus reducing handling and moving of parts since these operations are closely related.

Most of the carburized work processed in the large oven furnaces must be reheated and hardened out of the salt baths or the muffle furnaces.

Gas Atmosphere Heat Treating

The atmosphere furnaces are located in the rear section of the building but only about 15 feet from the large oven furnaces. The salt bath furnaces are across the aisle from the large oven furnaces. The Surface standard-rated atmosphere furnaces each have a hearth 22 inches wide by 36 inches deep and a door opening 14 inches high. A Surface 500 cfh MRX gas generator furnishes the atmosphere for the furnaces. (See Fig. 3). Work performed in these furnaces includes clean hardening, dry cyaniding, gas carburizing, straight hardening and skin recovery. An example of the work being done in these furnaces is the hardening of Torsion bars for large tractors. These bars are 3 inches in diameter by 40 inches long and must be held to very close hardness limits as well as straight tolerances. Crank shafts, gears and other similar parts are hardened regularly out of these furnaces with minimum distortion.

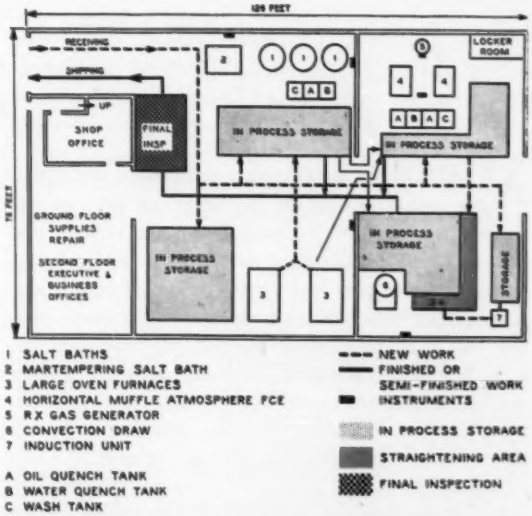

Fig. 5—Schematic layout of the equipment indicates the short travel distance from one operation to another.

Accurate and fast heating is accomplished by ten fully-piloted, tunnel-type burners that are alternately located to fire over and under the alloy muffle. The maximum operating temperature of 1750° F. makes it possible to heat treat many of the air hardening steels in addition to water and oil hardening types.

Tempering, Straightening and Induction Hardening

The tempering, straightening and induction area is located across the aisle from the atmosphere furnaces. Tempering is performed in a standard-rated Surface pit-type convection draw furnace 25 inches in diameter and 26 inches deep. Gas-fired, with a fan on the bottom to recirculate products of combustion, this furnace holds temperatures to within plus or minus 5°F. through the full range of operation which is 250° to 1250°F. (See Fig. 4).

Franklin Steel Treating Company has been operating for two years. Business has increased consistently, proving that quality standards and delivery schedules have been met. Success has been due to good management, versatility and low operating cost of the equipment as well as the layout of the furnaces to minimize handling. • • •

SPECIAL TECHNIQUES IN VACUUM METALLURGY

by **MICHAEL RIVERA**
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Editor's Note: *It was felt that to reduce this article in length to fit one issue would be to sacrifice its value, hence this is Part I of two parts.*

ADVANCES in metallurgical technology are among the prime movers in the onset of this jet and nuclear age. One of the most important keys to new materials and metallurgical techniques is high vacuum processing of metals and various other refractory high temperature materials. Advanced vacuum heat treating and brazing methods are yielding materials and structures with unique physical and chemical properties. Some of these materials and properties are either completely unobtainable by other means or they are otherwise prohibitively expensive to secure.

Induction vacuum melting techniques and the casting of these materials are much better known phases of vacuum metallurgy than certain aspects of heat treating by sintering and annealing or vacuum brazing. For this reason, this paper is devoted mainly to a discussion of the various sintering, annealing and brazing techniques recently inaugurated into vacuum metallurgy as well as a discussion of the specialized equipment required by these new processes and the problems which must be solved by the equipment manufacturer.

Fig. 1—A modular assembly with a resistance heater power supply, a high vacuum pumping system and a high temperature furnace unit.

Sintering

Vacuum processing and powder metallurgy, combined, produce special materials for the jet and nuclear fields. The common requirements of high speed aircraft and of nuclear reactor systems are for metals of high strength at elevated temperatures. Nuclear reactors, in particular, demand high temperature materials

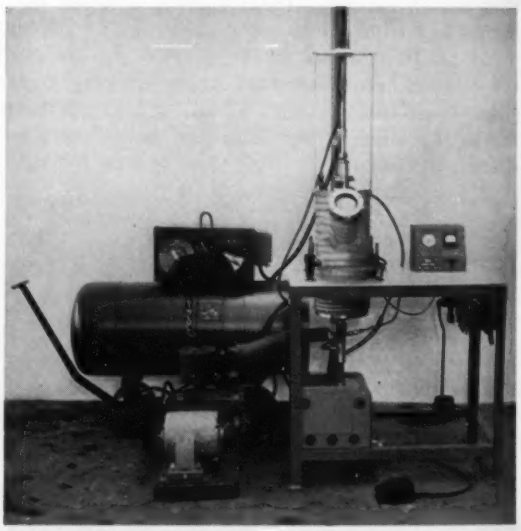


Fig. 2—A laboratory vacuum arc melting furnace having a spring-loaded bellows seal.

with good corrosion resistance and with specific thermal neutron cross sections in order to economically maintain desired levels of operation. New and unique requirements in these fields are being met by making use of refractory metals.

The production of high purity refractory metals by powder metallurgical methods calls for vacuum equipment either in the production of the metal powders themselves or in subsequent high temperature consolidation and densification. Hydrides of some metals such as zirconium and thorium, for example, are

heated under vacuum to yield their powders. Other refractory and reactive metals such as tantalum (melting point 5360°F.), columbium (melting point 4379°F.); and metal alloy mixtures, are pressed and then sintered under high vacuum to achieve consolidation without resorting to the higher temperature necessary to melt and cast them. At the same time, difficulties due to contamination from crucibles are avoided, and segregation and grain growth are minimized. The properties of the resultant materials depend not only upon the purity of the starting material, but also on the vacuum pressure during the high temperature sintering and cooling cycles.

High temperature high vacuum furnaces are also used in the production or processing of refractory hard metals such as carbides and borides. Although some carbides (such as chromium and uranium) dissociate at elevated temperatures and high vacuum conditions, others (zirconium, tantalum, columbium and tungsten) can be purified and densified by small additions of auxiliary metals or oxides. The presence of liquid phases promotes diffusion and the release of impurities from the carbide compacts. Eventually, during sintering the evaporation of all materials with lower vapor pressures results in a highly purified carbide product. Thus, the production treating of cemented hard metals is facilitated by the conditions available in high vacuum furnaces.

Annealing

Physical, chemical and electrical properties of metals may depend very strongly upon the residual gaseous impurities in the form of inclusions, absorbed gases, dissolved gases, or compounds formed through reactions with gases. Heating certain reactive metals, notably tantalum, titanium, zirconium, columbium and others in the presence of gases causes extensive oxidation and gas absorption with subsequent degradation of properties. Presence of higher gas residuals can limit ductility needed for cold working; absorption of hydrogen especially can result in embrittlement and change in electrical properties. Thin metal sections are particularly prone to deleterious effects due to gas absorption and diffusion. The electron tube industry requires metals of high purity and low gas content for vacuum tubes in order to maintain low pressure conditions, minimize erratic operation, and prolong tube life. In this respect, residual water vapor can be a source of difficulties. Vacuum annealing provides a method for extending control over these factors. As has also been reported, vacuum annealing facilitates complete harden-ability even in thin sections of certain age hardening alloys. Bright annealing of some alloys such as stainless steels is carried out under vacuum. The high temperature high vacuum dissociation of some oxides, nitrides, and hydrides results in cleaner metal and brighter surfaces.

Vacuum annealing is often preferred to inert gas annealing because it is less expensive and frequently produces a superior product. Inert gases have to be made up and maintained at given levels of purity. The use of vacuum very often allows the use of simpler apparatus with a lower first cost and lower operating expense. Extensive out-gassing is promoted, and the formation of unwanted compounds and absorption of gases upon cooling of the workload are minimized.

Brazing

High temperature brazing under vacuum conditions is a technique that is rapidly gaining popularity because of the superiority of the resultant joints. It is used in the aircraft industry for the joining of large assemblies, by the electrical industry for the manufacture of components, and by other fields in both metal-metal and metal-non-metal joints.

The vacuum conditions allow degassing and subsequent cleaning of the surfaces. It similarly promotes degassing of the filler material as it melts and flows. The formation of surface oxides or nitrides is hindered, and a more thorough wetting of the substrate

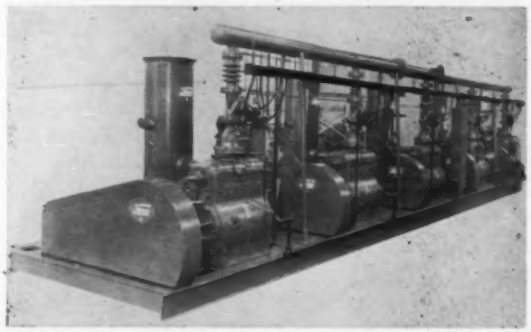


Fig. 3—Kinney mechanical vacuum pumps with a capacity of 780 CFM each.

takes place. Wider areas are covered by the filler, and gaseous inclusions in the joints are minimized. Thus, joints produced by vacuum brazing have higher strength, are brighter and cleaner, and are more resistant to corrosion.

Drawing a vacuum before backfilling with inert gases can also result in a number of advantages over conventional inert gas purging. Since low pressures can be reached, residual gases are at a minimum and the purging gas volume is thereby reduced. Complex brazing assemblies are also thoroughly purged by pre-evacuation.

Vacuum Furnace Equipment

Vacuum equipment for heat treating and brazing is available for research, pilot plant, or full production operations. As with other types of equipment built for investigation, furnaces for research and pilot plant work can profit by being provided with widely adjustable conditions of operation. These may include: a vacuum pumping system with a high reserve ca-

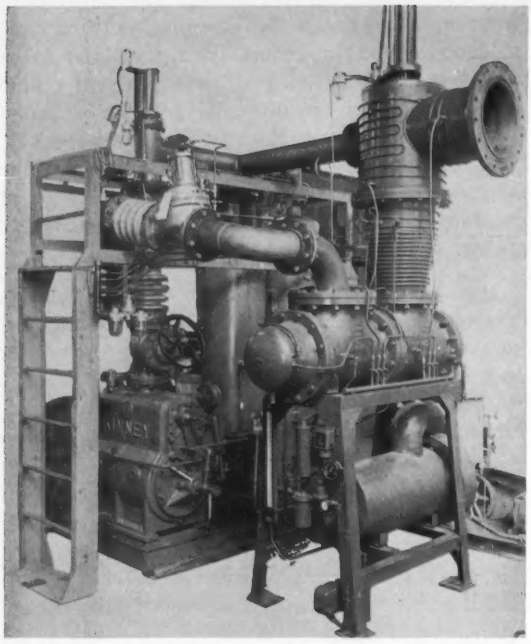


Fig. 4—A pumping system with a mechanical vacuum pump and an oil booster pump.

pacity, refrigerated traps for control over condensables, a wide range of operating temperatures, easy interchange of various types of heaters, flexible temperature programming, access to workload through various types of vacuum seals, and ports for visual and pyrometric observation.

Where required, recording of pressure and temperature, as well as special controls for long-period runs where supervision of the equipment is inconvenient, may also be included.

Production equipment is usually made much less flexible than laboratory equipment since it is designed for a specific purpose. In laboratories, skilled supervision is available, but production equipment must be as rugged as possible and must be operable with semi-skilled labor and with minimum of labor hours per unit produced. It must function continually with minimum maintenance. Automatic single purpose equipment to produce specific products are usual when the production phase has been reached. Such equipment may have automated valving, programming, specially designed facilities for rapid transfer of materials, various types of safety devices and alarms.

There are now available to metallurgical laboratories various types of laboratory vacuum furnaces covering just about all types of vacuum metallurgical operations presently known. One answer to the relatively expensive problem of a metallurgical laboratory in providing equipment for the dozen or more different operations which may be required is the modular approach in which vacuum pumping stations, furnace chambers, various heating elements and power supplies, vacuum gaging, and accessory apparatus can be put together and used in a variety of processes. Thus, relatively standard components and sub-assemblies can be combined into units which are best suited for the individual requirements of a research program and which can then be disassembled and recombined for the next problem, resulting in a great saving in the cost of equipment. Some problems are so complex as to require a custom-built laboratory furnace designed and constructed for a specific vacuum metallurgical operation. Fig. 1 shows a photograph of a modular assembly including a resistance heater power supply, packaged high vacuum pumping system, and a high temperature furnace unit. The furnace unit itself can be supplied with various heat treating, brazing and annealing elements. Processes such as quenching can be performed without breaking the vacuum or inhibiting flexibility. Equipment of this general type can handle just about any small scale vacuum metallurgical operation with the exception of arc melting, for which a special apparatus must be used in practically all cases. Such an apparatus is shown in Fig. 2.

Pumping Systems

The design of vacuum pumping systems usually hinges upon either the time allowable to reach a given pressure or a required volumetric speed at a given pressure. Processes that involve minimum gas loads are carried out with vacuum pumps that will evacuate a chamber in an economical period of time. Processes that result in high gas loads are carried out with pumps specifically chosen to have high volumetric capacity in the operating pressure range. Combinations of mechanical pumps, oil booster pumps, mechanical booster pumps, high vacuum oil diffusion pump and cold traps are used to satisfy process time and pressure requirements. The medium-to-high gas loads of vacuum melting, brazing, casting and anneal-

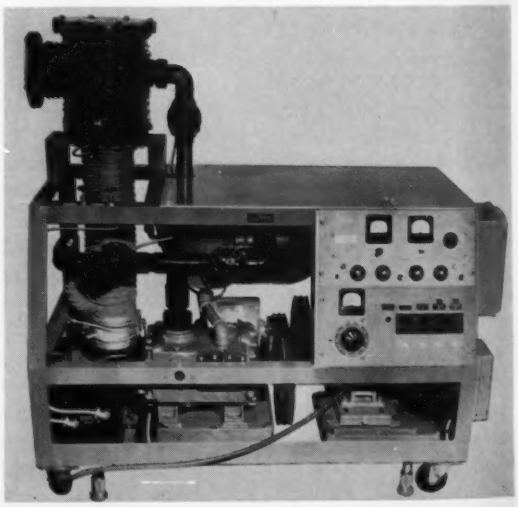


Fig. 5—A 6" high vacuum pumping system for use on high vacuum sintering furnaces.

ing may be handled by mechanical vacuum pumps alone, mechanical pumps, combined mechanical booster pumps, oil booster pumps, or oil diffusion pumps.

Fig. 3 shows a group of Kinney mechanical vacuum pumps with a capacity of 780 CFM each, which will operate at pressures down to 10 microns of mercury. Fig. 4 shows a pumping system made up of a mechanical vacuum pump and an oil booster pump. Fig. 5 shows a versatile 6" high vacuum pumping system which is used on high vacuum sintering furnaces and other apparatus. This unit includes two stage mechanical pumps, a high vacuum valve, high vacuum gages, and a fractionating-type high vacuum oil diffusion pump.

Furnaces

A variety of vacuum furnaces is available to the industry for research and production heat treating, sintering, deoxidation, melting, annealing, brazing, degassing, and melting point and phase studies. Their construction generally depends upon the size of the load and the temperatures to be obtained. Medium temperatures are obtained in muffle-type furnaces. Higher temperatures are obtained by "cold wall" furnaces with internal heating elements usually constructed of refractory metals. Still higher temperatures are obtained under the special conditions available in consumable arc and non-consumable arc furnaces.

Muffle and Retort Furnaces

Vacuum muffle and retort furnaces are used in heat treating, annealing, degassing and brazing. They can handle up to several hundred pounds and are generally more rugged in construction and use than other types, although they are limited in temperature by the material of the hot wall and by the heater elements. Muffles and retorts are constructed of stainless steel or Inconel, and heater elements of Nichrome or Kanthal for operation to approximately 2100°F. Furnace linings are made of insulating refractory brick.

Because of the reactive nature of many metals, especially at high temperatures, cooling under vacuum is a prerequisite for many metal-treating processes. Also, the solubility of gases in some metals increases with decrease in metal temperature. Thus, cooling at the lowest pressures is to be desired. In order to accelerate cooling, vacuum muffles are sometimes constructed with a cold zone adjacent to the furnace section. Work that has been heat treated is removed by vacuum sealed mechanical devices to the cold zone, there to undergo cooling at rates depending upon the process requirements. Fig. 6 shows a 10" I.D. vacuum muffle furnace of this type. Its capacity is several hundred pounds. Work loads in vacuum retorts are sometimes chilled by removing the retort from the hot furnace and exposing it to the air or to a water spray. Vacuum "bells" are chilled by lifting off and removing the heating jacket and exposing the vacuum bell to air or a water spray. Fig. 7 shows a special bell-type furnace.

Slightly higher temperatures of operations can be obtained by operating the heating elements in an inert atmosphere. However, retorts are limited by collapse due to atmospheric pressure. For example, on a muffle end plate 12" in diameter, there is a total pressure of about 1700 pounds. Lower strength and greater creep of even high alloys at temperatures of about 2100°F. limit their use to diameters of about 12". Larger furnaces up to several feet in diameter are made by enclosing the muffle or retort in a jacket and pumping out the space in between. Thus, the pressure bearing on the hot wall is reduced. Heater elements are placed in the space between the walls, the outer wall being protected by insulating refractories. This type of furnace is becoming increasingly popular for annealing and brazing of larger assemblies.

Cold Wall Furnaces

Much higher temperatures as well as lower pressures are often required for operations involving metals such as tungsten, molybdenum, tantalum, titanium, zirconium, vanadium, thorium, hafnium, uranium, columbium, and their alloys. Heat treating processes or work involving annealing, sintering, degassing and melting are carried out in furnaces that have the heat source within the vacuum chamber. Radiation shields are placed between the heat source and the chamber walls to prevent overheating and to minimize heater power dissipation. The chamber walls are usually water cooled, either by wrapping with copper tubing or by means of a double wall. The heater may be of the resistance type, or a susceptor in a high frequency field. In some cases the work load itself may be heated directly by passing current through it or by placing in a high frequency field.

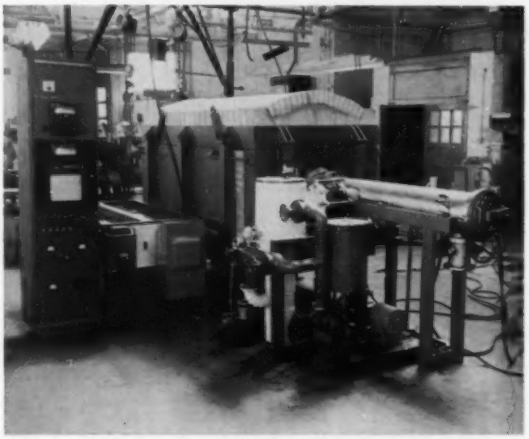


Fig. 6—A 10" I.D. vacuum muffle annealing furnace.

Besides creating high temperatures, these furnaces find wide application where specific, neutral or residual atmosphere and clean conditions are of importance. At very high temperatures and high vacuum, the residual atmosphere consists partly of water vapor

(*Continued on page* 46)

HEAT TREATING HIGHLIGHTS OF '57

By **ROBERT E. FLEMING**

Executive Vice President

Industrial Heating Equipment Association

ALTHOUGH 1957 orders for new heat treating equipment are expected to be off about 25% from the top peacetime year of 1956, technical advancements this year have continued at an unprecedented pace. Furnaces of new designs providing greater economies in production and with better results have rendered old equipment more obsolete and less profitable than ever. Even with furnace business off from the top year of 1956, heat treating equipment builders believe that this country is still in the midst of a dynamic economy which taxes the design and engineering talent of the industry.

During the past fifteen years the sale of industrial heating equipment has followed the same pattern as its sister industry, machine tools. However, in 1957 furnace business has held up considerably better than machine tool sales. Moreover, a recent survey of top management in the heat treating field reveals that expected 1958 business will recede only about 7% from the current year's orders received. However, it is anticipated that orders for steel mill furnaces in 1958 will be down in view of the tapering off of new mill expansions. On the other hand, modernization programs will take up some of the slack.

In the spring of 1957 an economic survey of significance occurred when the Metalworking Equipment Division of the U. S. Department of Commerce conducted its first comprehensive study of the industrial heating equipment industry for business and mobilization purposes. The fact that the survey was conducted is indicative of the growing importance of our industry in the estimation of our Federal government. It is clear-cut evidence that the industrial heating equipment industry has become one of the primary capital goods industries.

In addition to developing pertinent statistical data for the industry, the survey was designed to provide the government with up-to-date information on the capacity of the industry to provide heating equipment in the event of a national emergency.

Because of the importance of the Metalworking Equipment Division's survey and because no similar study has ever been made previously, the data generated is included in the accompanying Table. It will be noted that 1956 orders for all industrial heating equipment totaled in excess of $302 millions, while shipments for the same period amounted to $241 millions, of which 55% were in the factory-built category and the balance were field-erected equipment.

1957 Industry Trends

As was clearly anticipated by those close to the industry, automation and quality improvement in modern heat treating equipment pushed forward during 1957. The number and value of furnaces having automatic loading, heating, cooling and quenching cycles increased during the year. Our member firms see no change in this trend for 1958.

Operating temperatures are also on the rise, particularly in the field of experimental and research furnaces. These designs are to be followed by production equipment which will operate at phenomenally high temperatures. For these high-temperature furnaces, resistors of graphite, tungsten and other high temperature materials are becoming commonplace.

The use of atmospheres and atmosphere-control equipment is becoming increasingly important in difficult heat treating problems. Further, constant technical supervision of gas atmospheres is being replaced by more adequate methods of control built into the equipment.

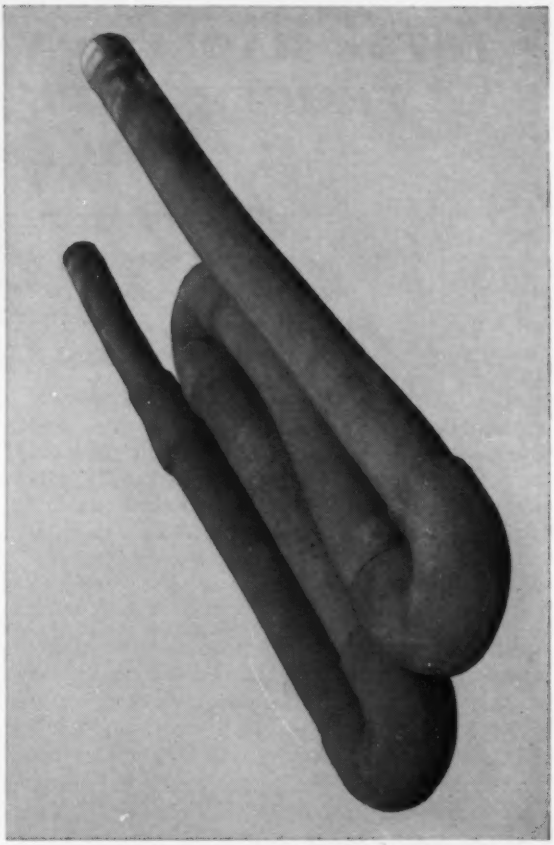
Another interesting trend which our members report is the use of larger furnaces. This is of considerable significance when it is considered that modern furnace equipment provides greater production facilities than older furnaces of comparable type and size.

Modern furnace designs are also giving emphasis to greater safety, the use of more efficient construction materials, and the never-ending search for greater overall economy of operation with increased production. Moreover, there are innumerable improvements and modifications being made in furnace components. For example, mechanical screw pushers are being used in place of hydraulic equipment for transporting heavy loads through the furnace, thereby eliminating fire hazards and the customary leaks in hydraulic systems. Most furnace builders are also improving operating mechanisms by the use of flexible chain drives for doors, pushers, extractors and transfers.

The vast amount of research on the part of the furnace builders in 1957 has been instrumental in developing better material applications. Silicon carbide, for example, has been proved superior for use in fur-

(Continued on page 44)

This unretouched photograph shows deterioration of 25-12 alloy radiant tube after 10 months service.



This unretouched photograph shows radiant tube of 22H still in serviceable condition after 78 months service in the hot zone where temperatures averaged 1850°F.

22H establishes new service record!

Has provided five times longer service life for radiant tubes in annealing furnace... and still going strong

Faced with mounting production losses and increasing tube replacement costs, a manufacturer of continuous weld carbon pipe began to experiment with the new high temperature alloy 22H for the "W" type radiant tubes in his annealing furnaces.

After seven years of in-use testing in all heat zones of the furnaces, this user found that the service life of radiant tubes made of 22H was increased far beyond the performance range of radiant tubes made of 25-12 type alloy.

After a total of 78 months service in temperatures ranging from 1700 to 1925°F., the 22H tubes were found to be in good condition and still continue in service. A 25-12 tube installed in the same position failed after 10 months service.

Since its introduction eight years ago, 22H has proven itself in many applications where severe operating conditions and elevated temperature ranges are the rule.

A National Alloy engineer will be glad to show you further proof of performance, and to discuss the use of 22H in your operation.

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National Alloy Division
Pittsburgh 38, Pennsylvania

THE MARK OF QUALITY NA NATIONAL ALLOY

B-7642

TOTAL RADIATION PYROMETERS FOR TEMPERATURE MEASUREMENT AND CONTROL

By **SABERT N. HOWELL** *and* **JOSEPH JERGER, JR.**
Staff Engineers, Design Engineering Department
Servo Corporation of America
New Hyde Park, N. Y.

THE GROWING demand for more automatically controlled processes in the metal working and treating industries has created a corresponding demand for accurate, automatic sensing and controlling devices. Since temperature control of processed materials plays a vital role in both metal working and metal treating processes, fast, accurate instruments to measure temperature variations from required conditions are of prime importance.

As all phases of metal treating technology are moving more toward the "continuous-flow" technique, the old methods of temperature measurement and control are not applicable. A system of *remote* temperature measurement and control is extremely necessary, since accurate measurement by direct contact is impossible without stopping a process.

The increased demand for higher production rates, coupled with the necessity for fewer rejects, has brought about the mass movement to continuous-flow metal treating. Already, automatic machinery based on this philosophy is being put into operation. However, this continuous-flow technique of production quickly points out the inadequacy of the present methods used in temperature measurement and control. In order to have a process operate continuously, all of the sensing elements must function without the need for stopping the process. Direct contact methods of temperature measurement must of necessity cause a stopping of the treating process.

All too often, operating personnel must rely on judgment and experience because of the limitations of existing temperature measuring equipment. Time has become one of the main sources of reference rather than temperature. In processes such as drawing and tempering, where the metal is in motion, temperatures are estimated against a time-base rather than by actual measurement. The analogous method (measuring the temperature of the surrounding medium rather than the material being treated) based on experience can provide acceptable products, but all too often brings about a high reject rate. The same inadequate analogous method is being used in aging, quenching, and stress relief processes.

With the advent of vacuum heat treating for atmosphere-reactive metals and the continuing investigations into the use of the new alloys and radically different metals, the importance of precise temperature control becomes even more critical.

Servo Corporatinon of America has successfully applied their infrared experience to measuring and controlling temperatures with their development of a new line of infrared radiation pyrometers specifically designed for industrial use. These electronic temperature detection and control devices can be located completely remote to a process and indicate the temperature of a given body to within an accuracy of 1%.

The applications of these instruments are many and varied. Because their temperature readings are independent of physical contact, they can be used where thermometers and thermocouples are inapplicable. Remote measurement is especially critical where the material being studied is in motion or inaccessible, or where it is abrasive, corrosive, or radioactive.

(*Continued on page* 40)

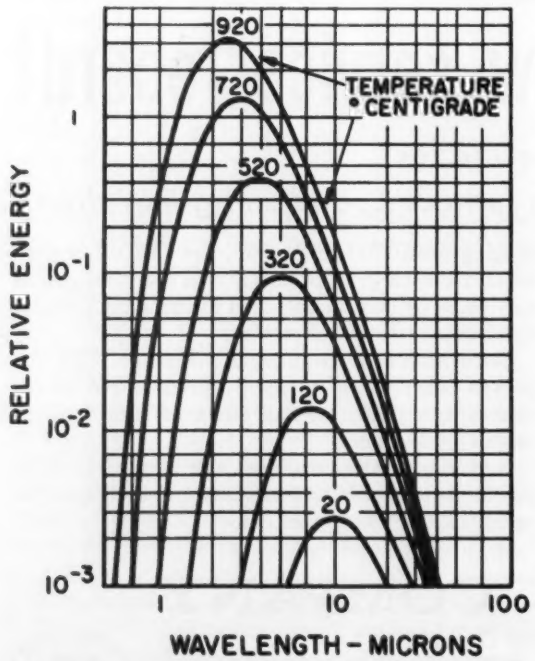
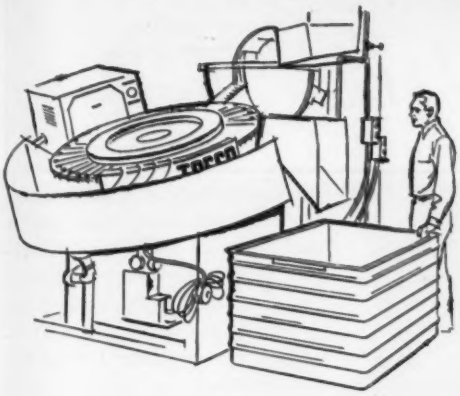


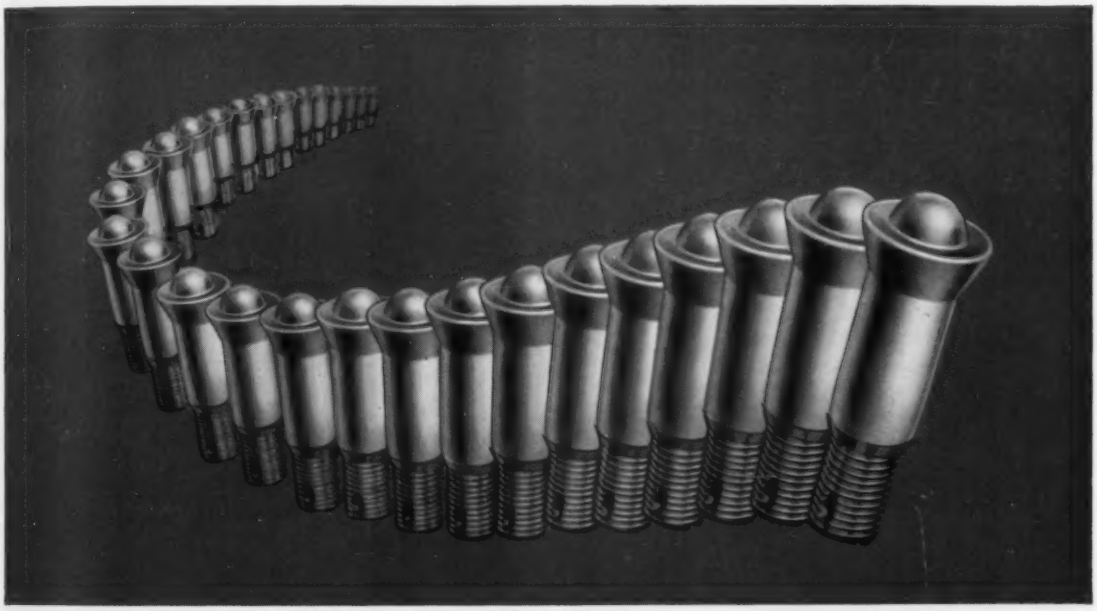
Fig. 1—Energy distribution of blackbody radiant energy with respect to wave length at different temperatures.

THOMPSON PRODUCTS ANNEALS THREADS ON BALL STUDS



ONE A SECOND!

with TOCCO Induction Heating*



Up Goes Production—When progressive engineers at Thompson's Michigan Division switched from conventional gas annealing to fully automatic TOCCO for annealing threads on automotive ball studs, production jumped from 2128 to 3226 parts per hour —an increase of over 50%.

Localized TOCCO heating draws threads from 60 to 30 Rockwell C, using 50 kw at a frequency of 10,000 cycles per second.

Down Go Costs—While production zoomed, costs dropped sharply with TOCCO annealing—a reduction of 34% in direct labor costs alone. With an average monthly output of 350,000 of these parts, Thompson saves thousands of dollars per year with TOCCO.

If you heat metal parts for annealing, forging, brazing or hardening, investigate how TOCCO can up *your* production and lower *your* costs.

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Please send copy of "Typical Results of TOCCO Induction Hardening, Heat-Treating and Annealing".

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M.T.I. *Activities*

1957 ANNUAL MEETING

The Annual Meeting of the Metal Treating Institute was held at the Hotel Sheraton, Chicago, Illinois, on November 1, 2, and 3, 1957. This was the 42d consecutive meeting of the Institute.

One of the outstanding features of the three-day meeting was the Special Luncheon on Saturday, November 2d, to which were invited as special guests the representatives from abroad attending the Second World Metallurgical Congress who were members of the division known as "Group IV—Heat Treatment." Nearly thirty representatives attended representing nine foreign countries, and a discussion on "Commercial Heat Treating Here and Abroad" was held. The spokesman for the foreign representatives was Mr. Bernard Jousset, General Manager and Chairman, Societe Parisienne de Cementation, Argenteuil, France, who spoke briefly as follows:

"Mr. Chairman and Gentlemen: Because I am a French custom heat treater, it seems to me that in spite of my bad English, it is my own duty to tell all of our American friends how much we appreciated their cordial and friendly welcome.

"It is especially a real pleasure for me to address my best thanks to those of you who, as American custom heat treaters, so kindly opened your plant doors so widely that we could see everything that was so very interesting to all of us.

"Your plants are indeed equipped with all of the modern facilities that it is possible to find at this time.

"Bravo, dear American friends, you are really a magnificent success. We are indeed a great family the world over.

K. U. JENKS
Newly-elected President of M.T.I.

"I think the exchanges of experiences between us at special occasions like this one are a very profitable way to insure not only the progress of our very special techniques but also to develop the ties of human friendship between all the nations of the Free World.

"That is really the only way to avoid another dreadful war and to increase the joy of living on our beautiful earth—better created by God than any human satellite."

Another of the highlights of the meeting occurred on Saturday, November 2d, when the President of the Institute, Mr. Howard N. Bosworth of Bosworth Steel Treating Company, Detroit, Michigan, made the presentation of the Annual MTI Achievement Award. This award is made annually to the author of the most outstanding lecture presented at the previous Annual or Spring Meeting or for any feature article appearing in the magazine METAL TREATING during the preceding year's issues.

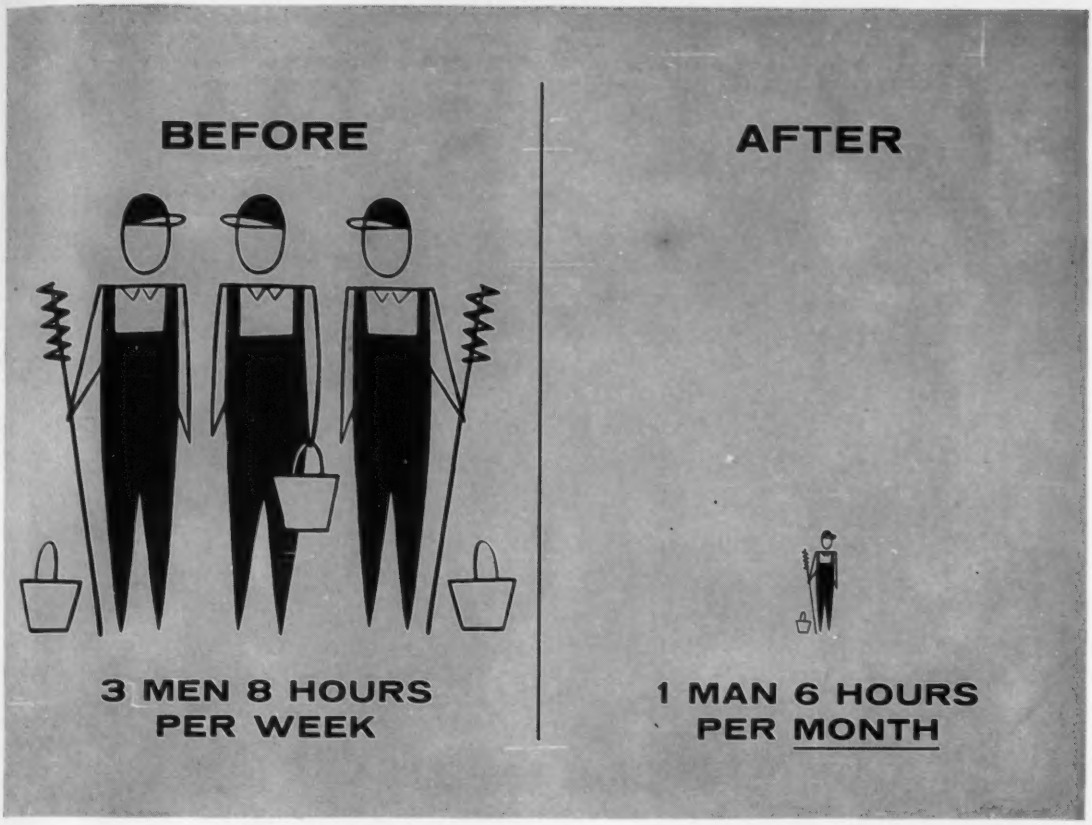
The winner this year was Paul D. Frost, Chief of Light Metals Division, Battelle Memorial Institute, Columbus, Ohio, for his article concerning the heat treatment of titanium published in the March-April issue of METAL TREATING and a subsequent lecture on the same subject delivered at the Spring Meeting of the Metal Treating Institute in April at Boca Raton, Florida.

Some outstanding speeches were also delivered during the technical sessions of the three-day meeting. On Friday, November 1, after President Bosworth's welcoming address, Mr. Joseph B. Kuhn, Metallurgist, and Mr. Ethan A. Smith, Jr., Development Engineer, both of The Beryllium Corporation, Reading, Pennsylvania, delivered an illustrated lecture on "The Heat Treatment of Beryllium Copper Alloys." An interesting discussion period of this talk was followed by the showing of a film entitled "Calder Hall" which dealt with the construction and operation of a British Atomic Energy plant.

Friday afternoon's session was devoted to two illustrated lectures. One was by Mr. Horace C. Knerr, President of Metlab Company, Philadelphia, Pennsylvania, whose subject was "Nitriding: A Heat Treating Method for Long Life and Negligible Deformation." The other was by Mr. Richard L. Hoff, Development Metallurgist, Superior Tube Company, Norristown, Pennsylvania, who talked about "Vacuum Heat Treating."

The session on Saturday morning, November 2d, was devoted to three interesting talks: Mr. Lucas S. Miel, President of Commercial Steel Treating Company, Detroit, Michigan, spoke on "The Importance of Cooperation"; Mr. Horace Drever, President of Drever Company, Philadelphia, Pennsylvania, talked on "The Heat Treating Industry as I Have Seen It Abroad";

(*Continued on page* 16)



A switch to Sun Quenching Oil Light resulted in this dramatic reduction in cooler-maintenance man-hours in a major automotive plant.

SWITCH TO SUN QUENCHING OIL LIGHT CUTS COOLER MAINTENANCE BY 94%

After switching to Sun Quenching Oil Light, a leading auto manufacturer reported a *94% reduction in cooler maintenance.* No heavy sludge deposit had formed on cooler coils after 18 months of continuous use. It took *fewer* men *far less time* to clean coolers.

Reason: Sun Quenching Oil Light has natural detergency and solvent action that *keeps cooling systems clean for long periods.*

It's Versatile. Sun Quenching Oil Light can be used in any type of quenching-oil system. It has uniform quenching properties and low drag-out.

It's Economical. Sun Quenching Oil Light can save you money two ways . . . in low initial cost and in reduced maintenance.

For Full Information, call your Sun representative or write to SUN OIL COMPANY, Philadelphia 3, Pa. Dept. MR-11

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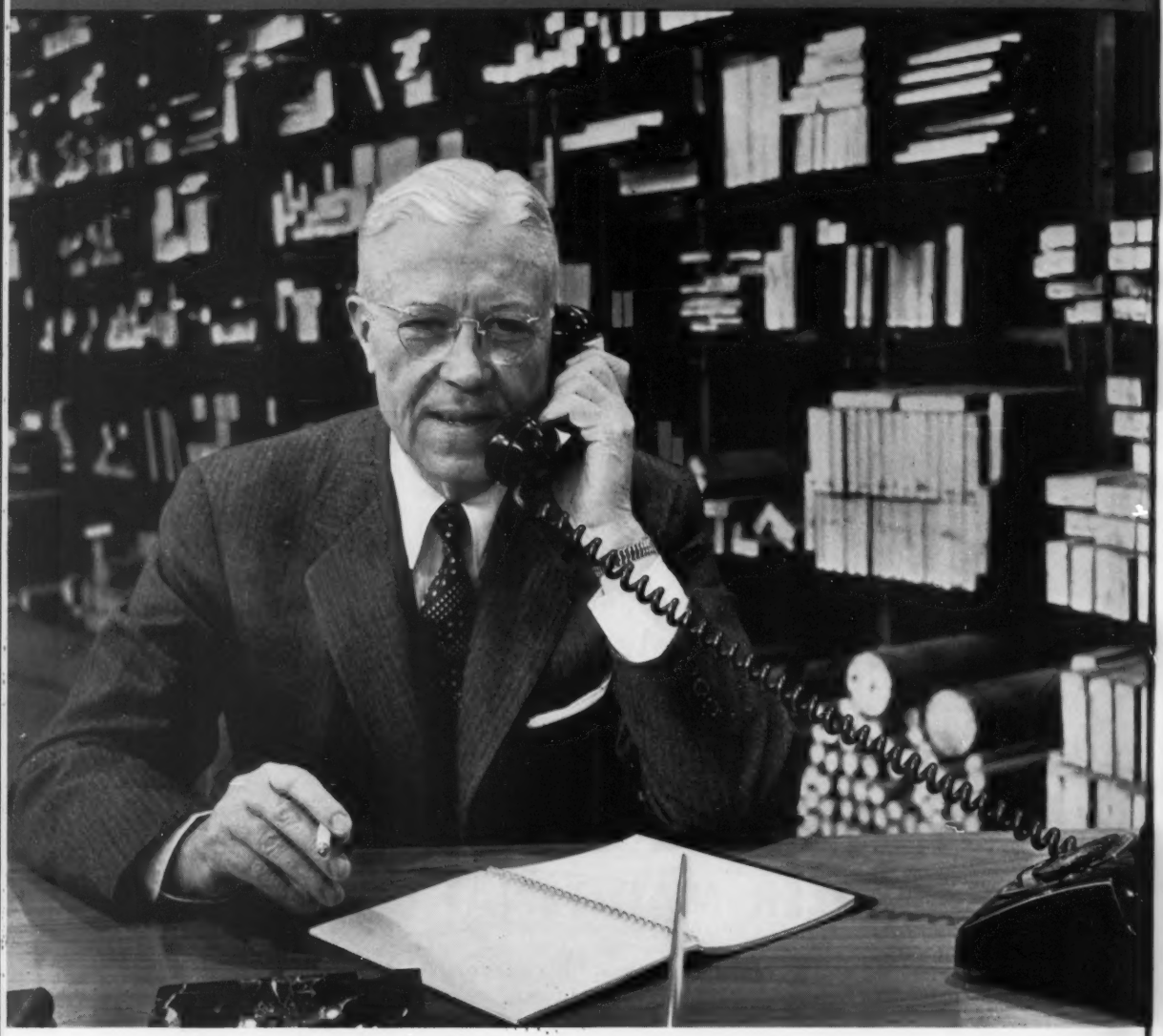
Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corp.



For Answers to Tool Steel Problems

CHECK WITH YOUR BETHLEHEM DISTRIBUTOR

Virtually every business day you are faced with a question or two about tool steel. On occasion the solution is relatively easy, such as ironing out some detail about delivery. But often it can be considerably more complex—perhaps weighing the merits of two similar grades, or determining the proper cycle of heat-treatment to obtain a more effective die life.

Whatever the problem, it calls for expert opinion, and that's where your Bethlehem tool steel distributor comes in. For he's a specialist in tool steel matters, and it's part of his job to see that your questions are answered promptly and courteously. Besides, he can also save you time when you need tool steel, for his diversified stocks are ready to go at a moment's notice. Make it a point to check with your Bethlehem distributor often. It will take but a few minutes at most, and it's one of the wisest moves you can make.

BETHLEHEM STEEL

"QUENCHOL® increased surface hardness to 60-62"

Mr. R. V. White

A large Mid-Western automotive transmission manufacturer was experiencing a costly problem: Spotty hardness in the machining of gears was causing reruns, rejects and scrap.

On a routine call, R. V. White, Sinclair Industrial Representative, was asked to help.

Mr. White reports: "The surface hardness requirements were 58-60 Rc, and were running only from 55-59 Rc. Based on previous experience, I recommended tests with Sinclair QUENCHOL® 524.

EXCEEDED EXPECTATIONS Mr. White continues: "QUENCHOL 524 increased the surface hardness to 60-62. Moreover, core hardness was increased from a minimum of 26 Rc to 30 Rc.

"The company changed immediately to Sinclair QUENCHOL in several small quenching units, and is presently preparing two 2000-gallon continuous units which will be filled with QUENCHOL 524."

If *you* have a problem with cutting oils and coolants, it will pay you to look into the advantages of Sinclair QUENCHOL 524. Contact your local Sinclair Representative, or write to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

Dino, the Sinclair Dinosaur, says:

"Contact your Sinclair Representative now."

SINCLAIR

CUTTING OILS AND COOLANTS

M. T. I. ACTIVITIES

(*Continued from page* 12)

and Mr. Howard N. Bosworth, President of the Institute, gave his "Thoughts About the Future of the Metal Treating Institute."

Sunday evening featured the Annual Reception and Banquet with entertainment provided by a floor show and dancing.

The following officers were unanimously elected at the business meeting on Sunday, October 7th:

President
K. U. Jenks
Lindberg Steel Treating Co., Inc.
1975 North Ruby Street
Melrose Park, Illinois

Vice President
A. T. Ridinger
Metallurgical, Inc.
900 East Hennepin Avenue
Minneapolis 14, Minnesota

Treasurer
L. G. Field
Greenman Steel Treating Co.
284 Grove Street
Worcester 5, Massachusetts

The following members of the Board of Trustees are serving the second year of their two-year terms:

Board of Trustees
John P. Benedict
Benedict-Miller, Inc.
Marin Avenue and Orient Way
Lyndhurst, New Jersey

John H. Ries
The Lakeside Steel Improvement Co.
5418 Lakeside Avenue
Cleveland 14, Ohio

Four new members of the Board of Trustees were also elected:

New Members
A. L. De Hart
Fred A. Snow Company
1942 West Kinzie Street
Chicago 22, Illinois

Clarence F. Graham
Metal Treating, Inc.
720 South Sixteenth Street
Milwaukee 4, Wisconsin

M. B. Dominy
Dominy Heat Treating Corp.
P. O. Box 5054—2707 Weir Street
Dallas, Texas

Norman R. Hodgson
Alfred Heller Heat Treating Co., Inc.
New York 38, New York

Past President Howard N. Bosworth became automatically an *ex-officio* member of the Board.

COMMERCIAL VACUUM FURNACE

The September-October issue of METAL TREATING (p. 26) announced the completion by Hollywood Treating Company of Los Angeles, California, of what is said to be the largest commercial vacuum heat treating furnace in this country available to private industry. Some additional information and a photograph are presented herewith.

The company made extensive surveys throughout the metalworking industry to determine the possible future need for vacuum heat treating equipment. The result of these surveys was the decision to design and manufacture the vacuum heat treating furnace shown here. Throughout all the developmental phases of this effort Hollywood Heat Treating Company received the support and encouragement of the major airframe and missile manufacturers. Approximately eighteen months were required for the design, development, and manufacture of the furnace. The "Shake-down" or initial operation of the furnace required two weeks during which time it was determined that the pump-down time was 50 per cent of design and that the maximum vacuum obtained exceeded design criteria.

Commercial Vacuum Furnace

MEMBER HONORED

Alfred M. Cox, President of Pittsburgh Commercial Heat Treating Company, has been elected president of the Smaller Manufacturers Council, Pittsburgh, Pa. An industrialist in various fields nationally,

Mr. Cox is president of J. P. Devine Manufacturing Co., and he also heads Pittsburgh Wire Form & Manufacturing Co. and Pride Manufacturing Co. Mr. Cox is also a past president of the Metal Treating Institute.

THE APPRENTICE CORNER

SURFACE HARDENING PRACTICES

Part III

By E. J. PAVESIC, *Director of Research*
Lindberg Steel Treating Company
Melrose Park, Illinois

Editor's Note: This is a continuation of the article which appeared in the July-August and September-October issues.

Cyaniding

This method of case hardening employs a molten sodium cyanide bath to produce a case rich in both carbon and nitrogen. The bath is comprised of mixtures of sodium cyanide, sodium chloride and sodium carbonate. Usual operating temperatures are within the range of 1400 to 1600°F. Beyond 1600° F the decomposition rate of sodium cyanide is too rapid for economical operation. The bath is operated at a sodium cyanide content of about 20 to 40%.

Cyaniding is used to produce case depths of from 0.001" to about 0.010" on a variety of low carbon steel parts requiring principally resistance to wear. A processing time of 1400°F for 15 minutes will produce approximately 0.001" case while 1600°F for 1 hour will produce approximately 0.008-0.010" case. Quenching in brine, water or oil is required to harden the case. The case is file hard.

Cyaniding baths are also used to heat for hardening certain gears and other machine parts made of medium carbon steels. Such heating provides a cyanided skin (case) which is harder and more wear resistant than the base material. (Carbonitriding is also used in this manner.)

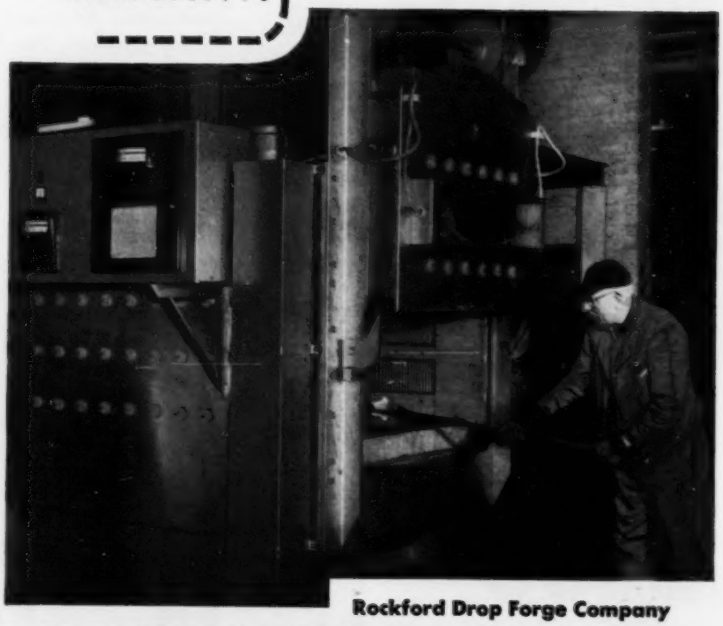
Nitriding—(Liquid)

This process of surface hardening employs a bath containing sodium and potassium cyanide or modifications thereof at temperatures of

"We needed straight-line even heating without lag or overshoot..."

so we ordered a

HEVI-DUTY BOX FURNACE



Rockford Drop Forge Company
Through-Hardens Upset Forging Dies To Maximum Hardness from 1850°F... with Improved Results!

"There is no doubt about the increased efficiency of our Hevi-Duty Furnace in this type of heat treating," says Carl R. Ree, Chief Metallurgist at Rockford Drop Forge. "The rapid heat up time... the equal, uniform heating... and negligible maintenance costs are features we like... plus the fact that this furnace is equipped with a saturable core reactor for stepless, proportioning control of power input!"

If you would like to increase the efficiency of many of your heat treating operations...

Write for Bulletin No. HD-441

HEVI-DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN
Heat Treating Furnaces... Electric Exclusively
Dry Type Transformers *Constant Current Regulators*

about 1000 to 1050°F to produce a thin, hard, case, high in nitrogen content. The process is used principally to nitride finished cutting tools made of high speed steel to improve their performance. The time of processing varies from about 15 minutes, to about two hours to produce case depths of approximately 0.0002 to 0.002" respectively. The case hardness produced is of the order of 92 to 95 Rockwell 15N or 65 to 70 Rockwell C although because it is so shallow it must be tested on a microhardness tester or with a test file.

The liquid nitriding process is not used generally for production nitriding of Nitralloy or other low alloy steels normally nitrided by ammonia gas. However it should be stated that any material which can be nitrided by gas can also be nitrided by the liquid process. Cold working die steels of the high chromium (5.00 to 12.50%) variety are sometimes liquid nitrided to enhance resistance to wear and galling.

Equipment used for the liquid case hardening processes described above include externally heated pot-type furnaces and refractory lined, internal electride furnaces. The pot-type furnaces are generally used for low volume production and the internal electrode furnaces for high volume production or when operating temperatures are consistently about 1650°F.

Nitriding—(Gas)

Nitriding is a surface hardening process in which nitrogen is introduced in a solid ferrous alloy by holding at a suitable elevated temperature in contact with a nitrogenous material, usually ammonia. The nitrogen combines with the alloy to form an extremely hard case of complex nitrides. Quenching is not required to produce a hard case. In the commercial application of the process, however, only steels containing some nitride forming elements such as aluminum, chromium, molybdenum and vanadium are nitrided. The most commonly used temperatures of nitriding are 950 to 1050°F although higher temperatures can be used.

Case depths attainable on Nitralloy 135 Modified steel (Cr-Mo-Al) by conventional nitriding at 975°F range from 0.005" in 5 hours to about 0.020-0.025" in 72 hours. For this same steel, the case hardness will be from 92-95 Rockwell 15N to 65 to more than 70 Rockwell C equivalent.

The nitriding operation is generally conducted in a gas-tight batch furnace (electric) or in a gas-tight retort externally heated and having appropriate gas inlet and exhaust means. After the work is loaded into the furnace or retort, the furnace or retort is purged with ammonia (or an inert gas) to eliminate all air. Upon completion of the purging operation, ammonia is introduced and the temperature is raised to the nitriding temperature. After holding at the nitriding temperature for the prescribed time which is commensurate with the case depth desired, the work load is cooled in the furnace or retort to about 300°F. Ammonia is constantly introduced during the cooling cycle to avoid explosions and discoloration through contact with air. During the nitriding cycle, the dissociation of ammonia is controlled, by regulating its flow, to 20 to 30%.

In recent years, the Floe Process of nitriding has gained increasing widespread use. The Floe method differs from the conventional method described above in that the ammonia dissociation is controlled to 83-86% by the use of externally dissociated ammonia and raw ammonia in fixed ratios. The Floe method also utilizes a two-stage cycle. First, the work is subjected to a temperature of 975°F and 20 to 30% dissociation of raw ammonia. Then a second state is applied using a temperature of 1050° F and 83-86% ammonia dissociation, and the latter accomplished by the use of mixtures of externally dissociated and raw ammonia. The

1500° IN 5 MINUTES

2300° IN 30 MINUTES

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NUMBER 120 HI-SPEED FURNACE

That's the kind of quick heating action you get with this compact, powerful furnace. It's economical to operate, too. Fast heat-up saves time and gas. High-temperature insulated firebox, 5" by 7¾" by 13½", gives even hardening of high speed and carbon steel dies, tools and small parts. Temperature easily regulated. G.E. motor and Johnson Blower included. 120,000 BTUs per hour.

Pedestal style, F.O.B. Factory....$184.00
No. 120 also available in bench style.

Write today for free Johnson Catalog

Johnson Gas Appliance Company

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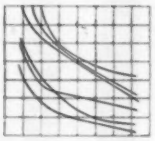
If it burns gas look to Johnson

Since 1901

What every good metal man should know about CARBONITRIDING

First of all, it is a good idea to know what equipment will do the best carbonitriding job for your specific requirement. And the best way to find this out is to talk over your problems with the people who have consistently developed the methods and equipment for better, more dependable, more economical carbonitriding results. That would be Lindberg.



Let's look at the record. Lindberg's contributions to carbonitriding and carburizing go far beyond just the building of furnaces to do it. It covers the development of controlled atmosphere generators, the creation of dew point equilibrium curves to establish proper atmosphere values for type of steel and temperatures involved and the exclusive Lindberg Carbotrol to maintain these values automatically in production.

Typical installation of Lindberg Hyen Atmosphere Generator, Lindberg Carbotrol and Lindberg Carbonitriding Furnace.

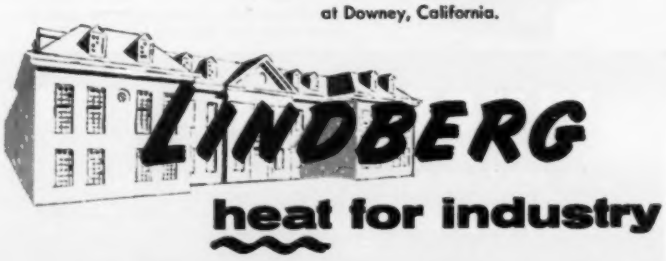
Then there is the invention of the "dimple" vertical radiant tube which gave new efficiency and economy to fuel-fired atmosphere furnaces. Lindberg's exclusive CORRTHERM electric heating element made practical the use of electricity in atmosphere furnaces.

Add to this our record over the years of building a broad variety of carbonitriding and carburizing furnaces, big ones, small ones, manuals, automatics, fuel-fired, electric, and it seems it's just good common sense to bring your heat treating problems to us. Just get in touch with the Lindberg Field Representative in your locality or write:

LINDBERG ENGINEERING COMPANY

2466 West Hubbard St., Chicago 12, Illinois

Los Angeles Plant: 11937 S. Regentview Ave., at Downey, California.



SIDE-BY-SIDE TEST proves advantages of WHEELABRATOR

STEELETTS®

- 75.8% savings in grit consumption
- 35.4% savings in grit costs
- 96.1% longer blade life
- 120% longer life for wheel parts

A large automotive plant cleaning heat treated work ran identical loads in two blast cleaning machines. The abrasive in one machine was chilled iron grit. The abrasive in the other machine was Wheelabrator STEELETTS.

Evaluation was made under production conditions for more than 9 months. The conditions for the two machines were identical with the sole exception of abrasive — only the grit used was different.

In that time, consumption of STEELETTS averaged only 5.8 lbs. per wheel hour compared to 24 lbs. for chilled iron. Cost per hour for STEELETTS was only $0.775 compared to $1.20 for chilled iron. Blade life with STEELETTS was 463 hours compared to 236 hours with chilled iron, and impeller and control cage life was 394 hours with STEELETTS and only 178.5 hours with chilled iron.

On every important count, STEELETTS outperformed chilled iron and brought savings. For those cleaning jobs that require an etched finish, investigate STEELETTS. No other grit can give the fast, thorough cleaning at such low cost.

For more information on this superior steel grit, write today for Bulletin No. 901-D.

WHEELABRATOR
CORPORATION
855 South Byrkit Street, Mishawaka, Indiana
WORLD'S LARGEST MANUFACTURER OF STEEL ABRASIVES

Floe Process, because of the higher dissociation used, produces a case with less so-called white layer of alloy nitrides. Such a case has less tendency to spall or chip and need not be ground. Because of the higher temperature used during the second stage, the Floe Process produces a deeper case in a given time than does the conventional single stage process. The use of externally dissociated ammonia and the high percentage dissociation maintained during the second stage result in a significant saving in cost of ammonia. Hardnesses attainable by the Floe Process are similar to those obtained in the single-stage method.

In addition to the Nitralloy steels containing varying percentages of carbon, chromium, molybdenum, aluminum and nickel, steels such as AISI-SAE 4140, 4340 and 6150 also are nitrided, although because of their lower alloy content they do not produce the intense case hardness typical of the former. Alloy cast irons and stainless steels can also be nitrided.

To develop the best nitrided properties, the steels should be pretreated (hardened and tempered) to produce a uniform microstructure of tempered martensite. The presence of free ferrite in the microstructure or decarburization (ferrite) on the surface is deleterious to the case properties, producing spalling and/or brittleness.

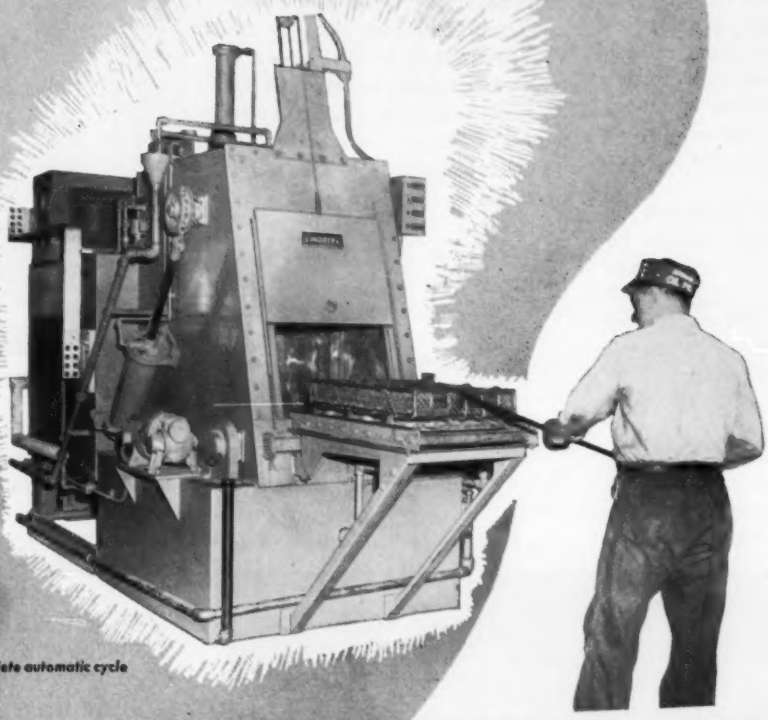
The nitriding process, because it is done at low temperatures, produces little or no distortion and often parts can be completely finished before nitriding without any necessity for corrective grinding or lapping afterwards. The usual practice on new nitriding applications is to process pilot samples to determine the amount of warpage, growth, and/or shrinkage and to make compensations therefore on future parts.

Parts can be selectively nitrided by employing bronze, copper or tin plate or tin oxide base paints on the areas desired soft. Econom-

(*Continued on page* 28)

Here's the work-horse

for many a carbonitriding job



This furnace has complete automatic cycle and quench control.

This is the most widely-used carbonitriding furnace of all. Day in and day out production of tons and tons of work has proved this furnace's ability to increase production quality and volume and reduce costs. It is a versatile furnace, too, not only for carbonitriding but for other uses, carburizing, annealing, carbon restoration and many hardening applications.

This type of furnace is available for both manual and automatic operation. It can be equipped either with Lindberg's efficient new vertical radiant tubes for fuel-firing or for electric heating with Lindberg's revolutionary new CORRTHERM element.

Versatile as this furnace is, we don't claim it is the best solution to *every* carbonitriding problem. But, whatever your need may be, talk it over with Lindberg. Our engineers, as they have done in so many instances, will recommend a sound answer—design it, build it, even field-install it if you wish. Just get in touch with the Lindberg plant or the Lindberg Field Representative in your locality. Lindberg Engineering Company, 2466 West Hubbard St., Chicago 12, Illinois. Los Angeles Plant: 11937 S. Regentview Ave., at Downey, California.

LINDBERG

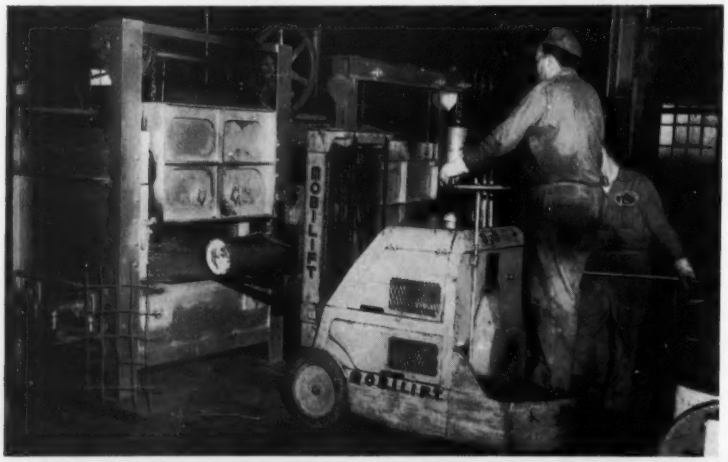
heat for industry

NEWS TO HEAT TREATERS...

TRUCK PROVIDES MANPOWER

In Cincinnati, Ohio, a part-time fork lift truck provides the manpower to handle red-hot containers and castings at Metal Treating, Inc. Although this company is a relatively new concern specializing in heat treating dies, they use mass production techniques in their operation. Here their stand-up industrial truck is a vital and irreplaceable member of their team.

The company was faced with the problem of handling items to be heat treated from receiving through processing to shipping. Like all plants, they required cranes and other types of hoists. But their building presented a special problem because the plant does not have a receiving dock. Obviously, they needed a lift truck to handle their receiving and shipping. A stand-up truck filled their specifications because of the dead-man brake, easy on-and-off, and every side visibility.



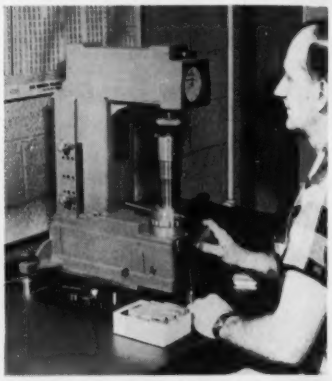
However, they did not confine their truck to the receiving and shipping departments, but moved it right out to help on the production line. It is used to place containers and castings into the furnace for heat treatment and to claim them from the furnace after processing. Without any special attachments the operator inserts the forks into the furnace, a helper using a long hook rolls the container onto the forks (See cut) and, as the container is placed on the forks, the operator tilts the mast. The container then rolls to the back of the forks and is held in place by the V-vice formed by the tilted mast and the forks. Despite the fact that the container is red-hot, it can easily be moved to the next operation. Since the driver can easily watch the whole operation, he can operate the tilt control which is at his fingertips. The dead-man brake insures both the driver and his helper that the truck will not move during this operation. These features guarantee the smooth operation of the production line. Besides handling containers, the truck is used to move trays of small parts both before and after treatment to and from the furnaces.

For further information circle No. 1

MOTORIZED HARDNESS TESTERS

Two new Kentrall motorized combination hardness testers have been announced by The Torsion Balance Company, Clifton, N. J. Available as standard models in both the 8" and 12" vertical capacities, these testers reduce operator fatigue by motorization of the major load.

These new Kentralls are also effective for laboratory work where only a few tests per hour are made. The advantage is greater standardization of test results because the "human element" has been elimi-



nated from the application and removal of the major load. This part of the test cycle is particularly critical because here the operator's technique has its greatest influence on test results.

Load flexibility is another feature of these combination testers. Either of these machines can make tests on all Rockwell Regular and Superficial scales.

For further information circle No. 2

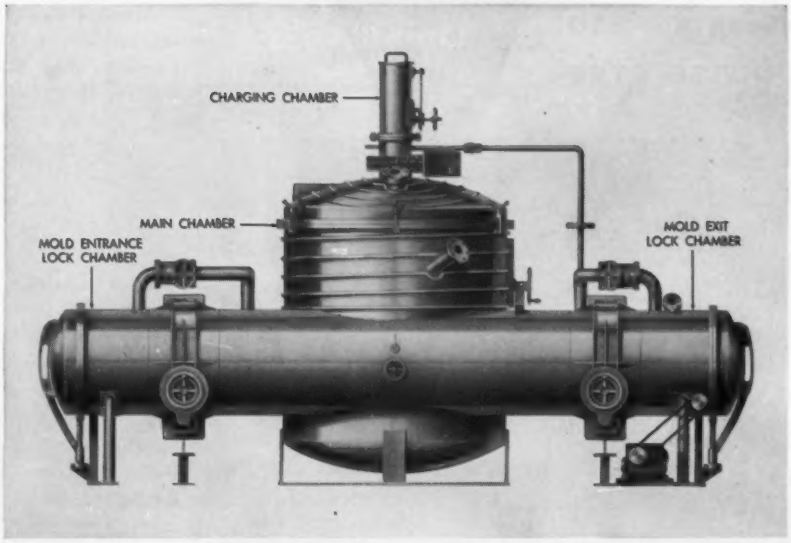
HEAT TREAT MANAGER

Harry F. Ross has been named manager of Ipsenlab of Rockford (Illinois), Inc., industrial furnace research and commercial heat treating organization.

Mr. Ross, a professional engineer

VACUUM FURNACES

by Kinney®



KINNEY 300 lb. High Vacuum Continuous Melting and Casting Furnace.

New Developments in High Vacuum Melting, Annealing, Brazing, Welding, Sintering, Stream Degassing and Heat Treating • • •

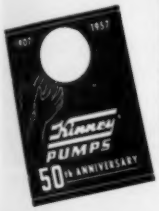
NEW HIGH TEMPERATURES
NEW HIGH VACUUM • *NEW HIGH* VOLUME

The Vacuum Melting and Casting Furnace shown above, as exhibited in the KINNEY Booth at the combined *Metals Show in Chicago*. This pilot plant or small production unit, designed for continuous operation, will melt up to 300 lbs. of Steel . . . (Zirconium, 250 lbs., Uranium, 725 lbs., and Titanium, 165 lbs.), forming small ingots or direct shape castings under High Vacuum or inert gas atmosphere. The unit has many interesting features and great versatility.

KINNEY High Frequency or Resistance Heated Sintering Furnaces enable you to work at 2200°C . . . Clean Vacuum . . . No Carbon! Pumping Systems are designed for *high, clean* Vacuum; frequently employing Fractionating Diffusion Pumps and Cold Traps. Special Pumping Systems are available for materials with high outgassing rates. Units can be modified for Sintering in inert atmosphere.

KINNEY Furnaces and Heat Treating Chambers, now in service, are setting outstanding performance records in the production of high purity Titanium, Germanium, Zirconium, Uranium, Tantalum, Beryllium, Silicon, Molybdenum and rare earth metals, as well as Stainless Steel, High Alloy Steel and the more common metals.

From laboratory and pilot plant to full scale production, the Vacuum "Know-How" of KINNEY engineers is a definite plus factor for you. Write for full information on the KINNEY High Vacuum Furnace to update your facilities.



WRITE—
FOR YOUR COPY OF THE PROGRESS REPORT TO THE METALS INDUSTRY DESCRIBING KINNEY VACUUM FURNACES

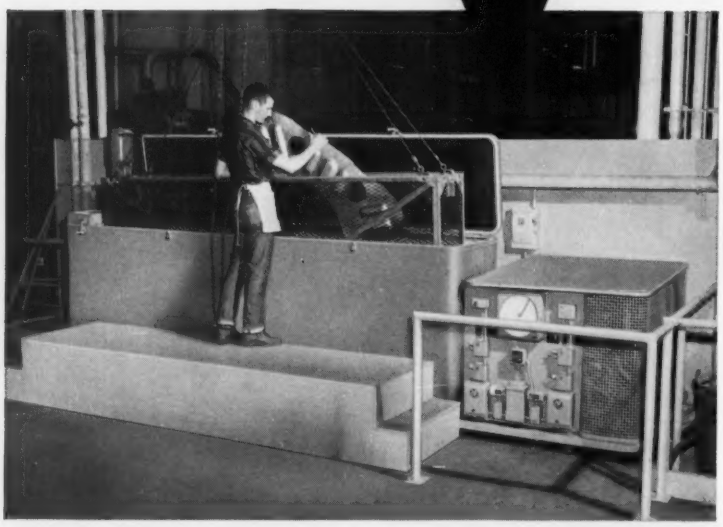
KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3594M WASHINGTON STREET • BOSTON 30 • MASS.

Please send me copy of your latest Bulletin describing new developments in Kinney High Vacuum Furnaces.

Name_____
Company_____
Address_____
City_____ Zone_____ State_____

. . . with this
Cincinnati
Sub-Zero
Chilling
Unit

NORTH AMERICAN AVIATION
cures and
stabilizes AM-350
STAINLESS STEEL



This 47 cu. ft. unit can bring 250 lbs. of AM-350 stainless from ambient to minus 120°F. in 60 minutes!

Stabilization of austenitic stainless steels and tools is accomplished quickly and safely at North American Aviation with a model 3SR-120-47 Cincinnati Sub-Zero Chilling Machine. Tailored to the specific application, this new 47 cu. ft. model completes the transformation from austenite to martensite without warpage, excessive scaling or distortion . . . produces high impact steel with good corrosion resistance.

The model 3SR-120-47 will be used extensively to eliminate retained austenite in the aircraft industry's "new" steels. Rocket and missile steel, for example, must retain hardness and dimensional stability at elevated temperatures.

Cincinnati Sub-Zero, a pioneer manufacturer with more than 16 years experience in the Design, Construction and Application of Low Temperature Equipment, can custom-build a unit to meet your specifications.

Outline your requirements for a prompt, no-obligation report.

Cincinnati Sub-Zero Products

General Offices & Plant: 3930 F-7 Reading Rd., Cincinnati 29, Ohio

registered in Ohio, was formerly metallurgist of Central Alloys Division of Republic Steel Corporation in Canton, Ohio.

A graduate of Purdue University, he is an active member of the American Society for Metals.

RELOCATED PLANT

Misco Fabricators, Inc., designers, builders and fabricators of heat resisting alloy and stainless steel equipment, has relocated in Marysville, Michigan, in the former Dow Magnesium Company building.

Misco, a division of Michigan Industries Co., Detroit, which in turn is a subsidiary of Consolidated Foundries & Manufacturing Corp. of Chicago, had occupied a section of the National Food warehouse building at 3564 Toledo Avenue in Detroit, which was destroyed by fire. Garth S. Thompson, president and general manager of Misco, said that machinery salvaged from the fire has been moved to the new plant located 45 miles north of Detroit on the St. Clair River. Also new equipment has been installed in the Marysville plant, and engineering facilities have been greatly expanded. The majority of the personnel from the burned-out Detroit location made the change-over to Marysville.

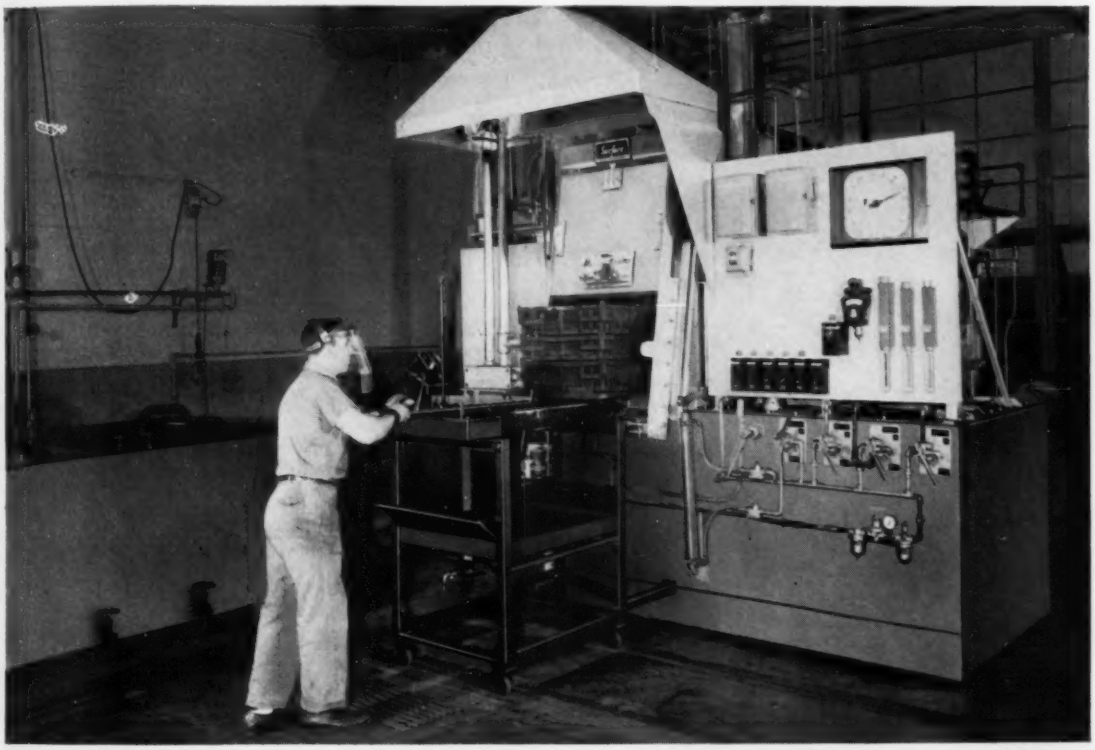
SOLUTION POT

A new type of solution pot with a cast bottom and wrought side is announced by General Alloys Company, Boston, Mass.

The best features of casting and wrought material are combined in

(*Continued on page* 28)

Allcase® furnace clips cost ½ on manicuring implements



One man and one furnace now match the former production of two men and two furnaces in this plant. Added to this gain are two others: greater versatility in processing, and finished work of uniformly high quality. The latter is especially important to this manufacturer of manicuring implements, because he offers a lifetime guarantee on many of his products.

The "hero" of this story is the Surface Allcase® furnace, which is used for hardening, carbonitriding, carburizing, and annealing. Controlled atmosphere is supplied by a Surface MRX® gas generator. Work handling and atmosphere control can be completely automatic, if you wish. Why don't you find out about this profitable furnace now?

Write for Bulletins SC-163 and SC-174.

Surface Combustion Corporation, 2381 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

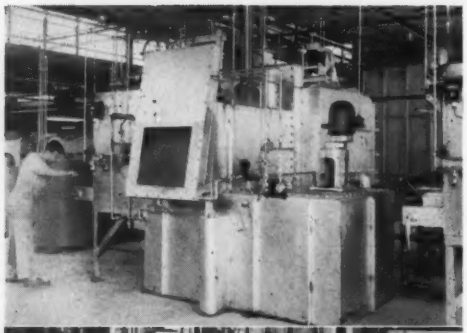
wherever heat is used in industry

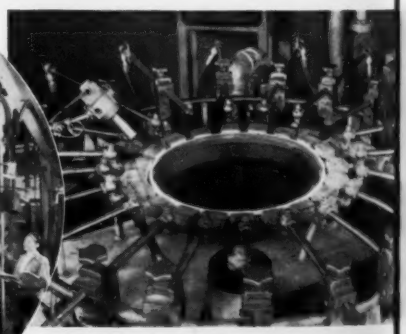
Surface

WHEN IT COMES TO HEAT TREATING

"Do-It-Yourself" can sometimes be costly

Buying equipment and supplies to perform heat treating operations within your own plant is only one step in many that must be considered when contemplating the installation or expansion of a heat treating department.





Here are some of the factors that should be included when figuring the cost of operating your own heat treating department—of "doing-it-yourself" when it comes to heat treating:

- **Technical skill:** Trained operators whose skill is the result of years of experience are essential
- **Maintenance:** Rapid deterioration of equipment occurs unless there is constant repair, maintenance, and skillful handling of the equipment
- **Quality control:** Testing equipment and skilled operators are necessary to maintain uniformity and quality control of all heat treating operations
- **Sufficient equipment and supplies:** A great variety of equipment is needed to meet the requirements of annealing, brazing, hardening, carburizing, stress relieving, nitriding, and all other heat treating processes; and an endless variety of materials and supplies must be kept on hand.

These problems and many more have been solved by commercial heat treaters. They have the answers because heat treating is their business.

Every MTI commercial heat treater listed here is a specialist with complete service facilities under one roof. Each one has the facilities, equipment, skill and experience which will enable him to meet your most exacting heat treating requirements.

When you have heat treating problems or need heat treating services . . . write

METAL

FOR THE BEST IN COMMERCIAL HEAT TREATING—

Consult these companies:

CALIFORNIA

Certified Steel Treating Co.
2454 E. 58th St., Los Angeles 58
Hollywood Heat Treating Co.
6902 Santa Monica Blvd., Los Angeles 38
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12

ILLINOIS

Seneca Heat Treating Co.
124 S. Batavia Ave., Batavia
Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Dura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22
Pearson Industrial Steel Treating Co.
5757 W. Ogden Ave., Chicago 50
Perfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kinzie St., Chicago 22
American Steel Treating Co.
P. O. Box 225, Crystal Lake
Eklund Metal Treating, Inc.
721 Beacon St., Loves Park
Lindberg Steel Treating Co.
1975 N. Ruby St., Melrose Park
Ipsenlab of Rockford, Inc.
2125 Kishwaukee Street, Rockford
O. T. Muehlemeyer Heat Treating Co.
1531 Preston St., Rockford
C. U. Scott & Son, Inc.
1510 First Ave., Rock Island

INDIANA

Quality Steel Treating Company
1630 Locust Street, Anderson

MASSACHUSETTS

Kinetics Corporation
3 Churchill Road, Hingham
New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
Greenman Steel Treating Co.
394 Grove St., Worcester 5

MICHIGAN

Anderson Steel Treating Co.
1033 Mt. Elliot Ave., Detroit 7
Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Standard Steel Treating Co.
3467 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Lincoln Heat Treat, Inc.
21235 John R, Hazel Park
Metallurgical Processing Company
2703 East Nine Mile Road, Hazel Park
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1727 Manchester Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Metal Treating Corp.
611 Grove St., Elizabeth
American Metal Treatment Co.
Highway 25 & LaFayette St., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Fred Heinzelman & Sons
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E, Rochester 5
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 25
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 West Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Robert Wooler
Limekiln Pike, Dresher
J. W. Rex Co.
834 West 3rd St., Lansdale
Drever Company
220 West Cambria St., Philadelphia 33
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Wiedemann Machine Co.
4272 Wissahickon Ave., Philadelphia 32
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 1686, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
830 S. 5th St., P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

M.T.I. MASTER CRAFTSMEN

TREATING INSTITUTE

AVENUE NEW ROCHELLE NEW YORK

(*Continued from page* 20)

ically, nitriding is limited to applications which cannot be satisfied by other methods of surface hardening. This is due to the necessity of using more costly alloy steels which require heat treating prior to nitriding and the more costly nitriding operation itself. Typical nitriding applications include aircraft gears, pump shafts and cylinder liners.

Other Processes of Surface Hardening

A more recent development in the field of surface hardening involves that of pressure nitriding. In this process (patented), the articles to be processed are subjected to the action of ammonia gas at pressures of about 100-200 PSI or more and at a temperature of 1000°F. The process is reported to be particularly adaptable to the nitriding of internal tubular surfaces. Savings of time and cost of ammonia are also reported. Case properties are the equivalent of those produced by other nitriding methods. Special equipment and/or techniques are required because of the pressures involved.

There are also in varying degrees of usage throughout industry a number of proprietary processes, patented or otherwise protected, for surface hardening. These are used to produce properties and characteristics similar to those produced by the processes described above. However, many of the proprietary processes produce special properties or characteristics and may provide advantages not inherent in the other processes described.

(Part IV will appear in the next issue.)

(*Continued from page* 24)

this new pot for maximum service life and reliability.

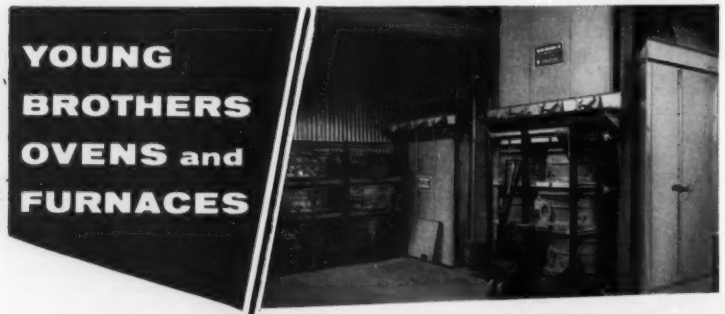
The cast bottom is uniform throughout, and its superior strength prevents sagging and deformation of the pot during use. It is available in any size or shape, in any heat or corrosion resistant metal in thicknesses from 3/16" up to 1" or more.

For further information circle No. 3

MARKETING MANAGER

William F. Ross has been named marketing manager of Ipsen Industries, Inc., Rockford, Illinois, manufacturers of industrial heat treating equipment, and also of Ipsenlab of Rockford, Inc., and Ipsenlab of Canada, Ltd., industrial furnace re-research and commercial heat treat-organizations.

A graduate of the University of Michigan College of Engineering, Mr. Ross holds a degree of Bachelor of Science in mechanical engineering and is a Registered Professional Engineer.



Electrically heated, controlled atmosphere furnaces.

for Greater *ECONOMY* and *EFFICIENCY* in
HEAT TREATING

Young Brothers Ovens and Furnaces are the product of 60 years of experience in building ovens and furnaces for all heat treating processes. As a result they operate more efficiently, turn out more and better production and meet the exact requirements for which they are engineered.

Knowing the basic problems of heat treating, Young Brothers Engineers have perfected ovens and furnaces that operate reliably, provide large savings in fuel and handle a wide variety of work requiring a broad range of temperatures and heating cycles.

For better heat treating results in less time, at lower cost, investigate the exclusive advantages that Young Brothers Ovens and Furnaces offer. Write for Bulletin 157.

YOUNG BROTHERS COMPANY
1849 Columbus Road Cleveland 13, Ohio

SELF-CONTAINED ULTRASONIC CLEANER

At the Metal Show, a self-contained cleaning set-up in a single cabinet was the newest item shown by Branson Ultrasonic Corporation, Stamford, Conn. Including a heater, temperature control, filtration and recirculation system in addition to the ultrasonic generating equipment, it is nonetheless small enough to be moved about easily. Overall dimensions are 22" x 19" x 37" high.

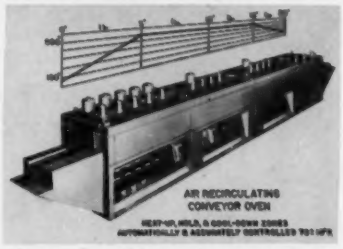
The size of the tank itself is 6" x 16" x 11" deep, with a total working volume of 5 gallons. The transducers mounted to the bottom have a rated input of 250 r-f watts average (1kw peak), which they convert into mechanical vibrations at 38 kc. This high-speed agitation causes cavitation in the liquid, providing a gentle but thorough scrubbing action. Even insoluble soils may be removed in minutes—sometimes seconds—and little operator attention is necessary.

For further information circle No. 4

CONVEYOR OVEN

Electric Hotpack's new Air Recirculating Conveyor Oven, with controlled temperature to 1800° F, plus or minus 20° F, has four separate temperature zones covering a four-hour heat treating period, and enclosing a twenty foot space.

Forced air blowers transmit heated air across the treated material insuring even and uniform distribution of heat throughout the oven sections, each controlled by one or more indicating-controllers.



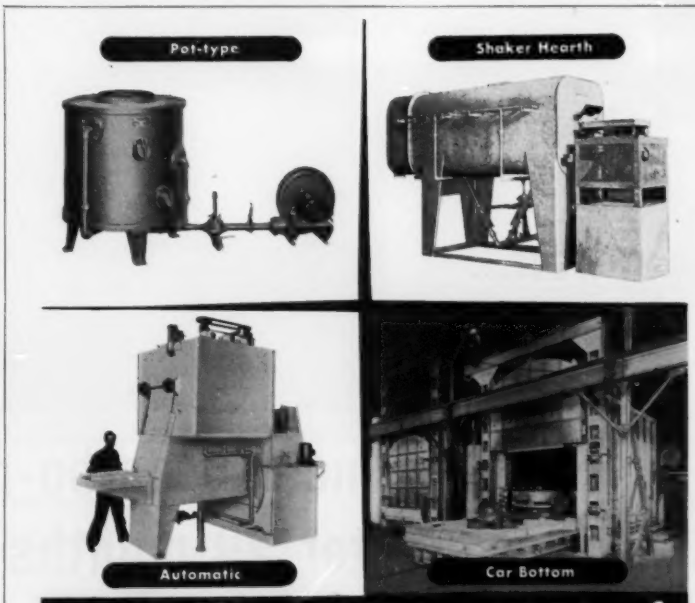
For further information circle No. 5

NEW ATMOSPHERE FURNACE

The Kleenmetal Controlled Atmosphere Furnace, designed and built by W. S. Rockwell Co., Fairfield, Conn., includes two methods of cooling the heated product in protective atmosphere.

The furnace is designed for heating to 2400°F. This takes in a wide scope of operations such as annealing, hardening, non-decarburizing heating, silver or copper brazing, sintering powdered metals, etc. Introductions of exothermic or endothermic gas or dissociated ammonia provide furnace atmosphere. This furnace is furnished with globar electric heating elements but may be built for gas or oil heating and muffle.

(*Continued on page* 32)



DFC offers MANY TYPES of INDUSTRIAL FURNACES

Your needs for a custom or standard model of any type heat treating or melting furnace can be met economically and effectively by DFC. Experience spanning many decades in furnace design and refractory manufacture combined go into every modern unit. Our quotation does not obligate you in any way. Write for literature, stating the type equipment you are interested in.

DFC The Denver Fire Clay Company
3033 Blake Street, Denver, Colorado

Outlasts former baskets four to one...

Wrought Inconel carbo-nitriding basket still in use after 29 months

This Inconel* nickel-chromium alloy basket is built by Rolock, Inc. for the Progressive Metal Treating Co., Bridgeport, Conn.

Progressive uses it for carburizing, nitriding and annealing small steel parts in their Ipsen gas-fired, batch-type furnaces.

After 29 months of continuous heat-treating service it *still* has plenty of life left, despite the fact that it's already outlasted previous baskets four to one.

The basket's twin has done just as well. Ten others, purchased later are expected to do the same.

Inconel alloy contributes four ways to long life

In this instance, Inconel alloy overcomes (1) early weld failures; (2) excessive oxidation; (3) the thermal shock of 1750°F to 150°F oil quenches; (4) progressive losses in initial strength due to corrosion.

Inconel alloy also contributes a high strength-to-weight ratio. Light as they are, the baskets can easily handle the 340-pound work loads.

For information on other successful ways to increase the life of heat-treating equipment with Inconel alloy, write for the Inco booklet, "Keeping Costs Down as Temperatures Go Up."

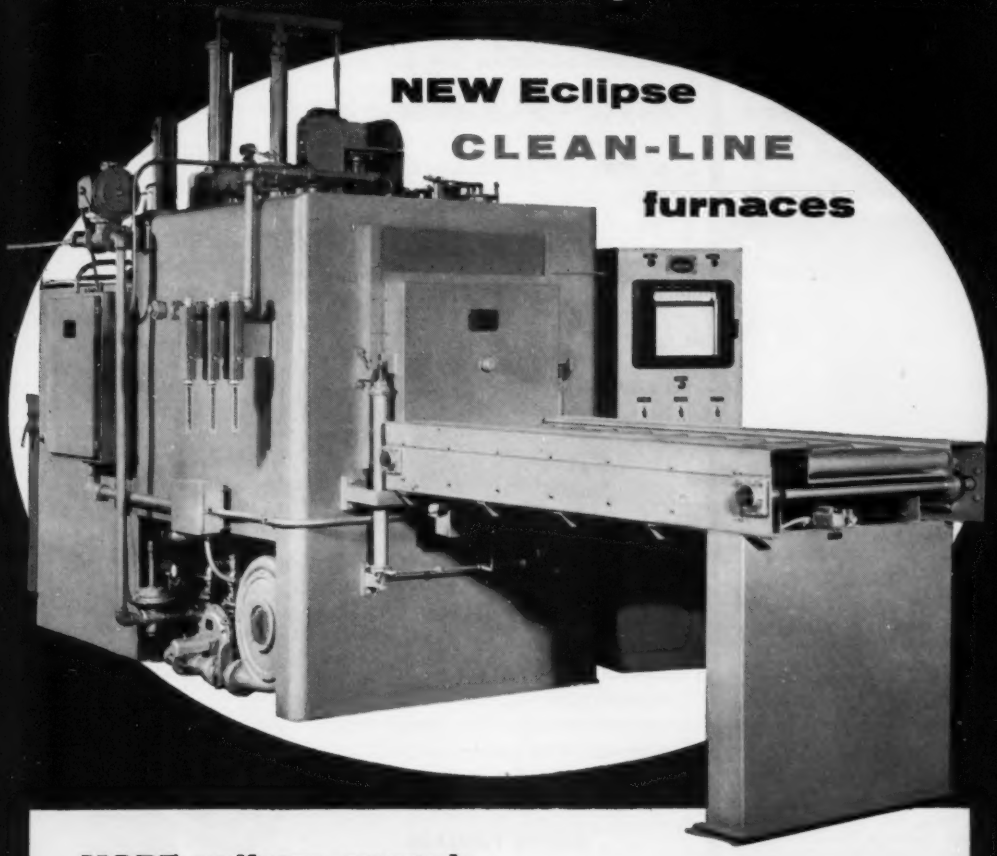
*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N.Y.

INCO TRADE MARK NICKEL ALLOYS

INCONEL... *for long life at high temperatures*

Brings more uniformity to heat-treating



MORE uniform quench

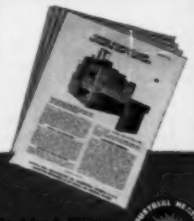
MORE uniform heat

MORE uniform case depth

All these "plusses" are yours with the new Eclipse Clean-Line furnace because: (1) atmosphere and temperature are distributed with complete uniformity during heating — there's no stratification — and (2) even tightly packed loads of the smallest parts are quenched uniformly in the oil jet-agitated tank served by the high-capacity pump. The Clean-Line furnace, rated to heat-treat 400 lb of work in one hour, and with quench capacity for 700 lb per load, is designed for fully automatic clean hardening, carbonitriding, carburizing, carbon restoring, or annealing. Standard Clean-Line furnaces are designed for operation at temperatures up to 1850° F.

Complete control of all heat-treat operations is right at your fingertips. You can select an air or oil quench, for example, just by flicking a switch on the control panel. Heating cycle, high oil pump circulation, and quenching cycle for a particular workpiece can all be controlled precisely and automatically by three separate timers on the control panel. All these features add up to better quality — every piece in every batch.

WRITE for bulletin and data sheets describing the Clean-Line system that includes endothermic generators, automatic washers, and tempering units.



Eclipse®

ECLIPSE FUEL ENGINEERING CO., 1018 Sechanon Street, Rockford, Illinois

ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD., 20 Upjohn Road, Don Mills, Ontario

IHEA

test hardness of

CASTINGS
FORGINGS
BARS

the *best* way
with Steel City
Brinell Testers

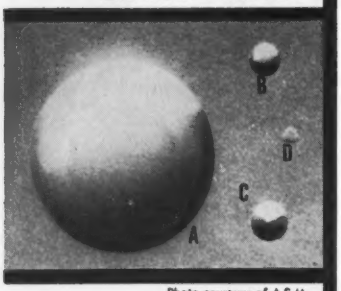


Photo courtesy of A.S.M.

Photograph illustrates the comparative size of impressions made by four different types of hardness tests:

(A) Brinell, (B) Rockwell "B", (C) Rockwell "C", and (D) Scleroscope. Because it covers a larger area, the Brinell impression (A) averages out small inequalities in hardness, surface finish, and complex internal conditions of the metal.

Steel City Brinell Hardness testers are designed to efficiently provide a *true* picture of the hardness of castings, forgings, bars and other comparatively rough and soft forms of metal. Models are available to facilitate the handling of the work with minimum of effort. *True, round Brinell impressions assure dependable testing results.* If a Brinell Hardness test is indicated for your material or product — contact Steel City for the *right* testing machine.

If one of the following types of test is your need—let us help you choose the Steel City machine that meets your individual requirement.

Ductility | Brinell Hardness | Tensile
Compression | Transverse | Hydrostatic
Proving Instruments | Flex-Tester

Write today for FREE literature, describing Steel City testing machines.

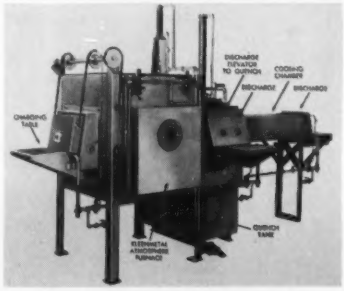
Steel City Testing Machines Inc

8805 Lyndon Ave., Detroit 38, Mich.
Sales offices in all metal working areas

NEWS TO HEAT TREATERS

(*Continued from page* 29)

A unique feature is the quenching system incorporated between the discharge end of the furnace and the cooling chamber. This consists of a steel oil quench tank equipped with propeller type agitator and a roller rail type rack-elevator which is actuated by a constant speed, smoothly moving pneumatic cylinder operated by a foot treadle. The rate of lowering the rack of work can be adjusted and held constant for duplicating quenching results.

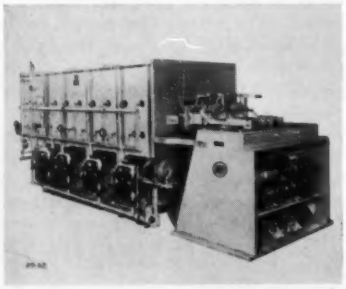


The quenched work is then raised and removed through the side discharge opening. However, for atmosphere cooling, the work may be pushed through the tunnel-type, water-jacketed cooling chamber and discharged at the rear end.

For further information circle No. 6

SHAKER FURNACE

Twin Hearths for "double production" have been provided in the new Shaker Furnace announced by the American Gas Furnace Co., Elizabeth, N. J.



Two parallel sealed hearths are mounted in this new type of furnace to double the heat treating production of the same work or to heat treat two different types of parts which require the same atmosphere for processing at the same or different time cycles.

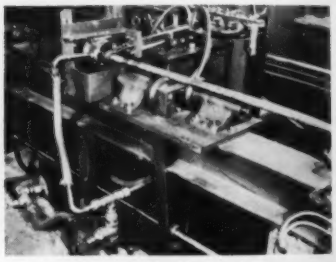
Each hearth is individually controlled for operating speed, and the work advances automatically by the regularly interrupted reciprocating movement that carries the work through the controlled atmosphere.

For further information circle No. 7

INDUCTION HARDENING

A new application of high frequency induction heating is shown in this Thermatool Progressive Rod Hardening Mill. Uniform hardening of mill length shafting to specified hardness and depth is achieved in continuous production with push-button simplicity.

Designed and built by New Rochelle Tool Corporation, New Rochelle, N. Y., for metal working shops, it is said to harden carbon steel rods up to 4" in diameter and 30' plus in length—without distortion, thus eliminating the usual straightening process.



A close-up view of the heating section shows a steel rod in the process of continuous hardening as it passes through the induction coil. The coil is energized by a 50 kw, 9600-cycle motor generator. The drum-shaped unit is a water quenching spray fed by the pipe at the left.

For further information circle No. 8

ENDOTHERMIC GENERATOR

Hevi-Duty Electric Company announces a new, more efficient, easier operating, lower cost endothermic generator. It is a complete compact unit consisting of a catalyst-filled heating chamber, gas pump, heat exchanger and controls all mounted on a sturdy steel frame. The atmosphere can be used in furnaces performing any of the following heat

From Park Research Laboratories

HOW TO SELECT THE RIGHT METAL CLEANER FOR YOUR JOB

Selection of the right metal cleaner depends upon whether the cleaning is to be done in a power washer or soak tank, and whether electrolytic or emulsion cleaning is to be used. Also to be considered are the parts to be cleaned and whether inorganic or organic matter is to be removed.

While inorganic matter, which includes rust, scale and oxide, may be removed by either mechanical or chemical means, organic impurities—such as oil, grease and drawing compounds—are most effectively removed by chemical reaction.

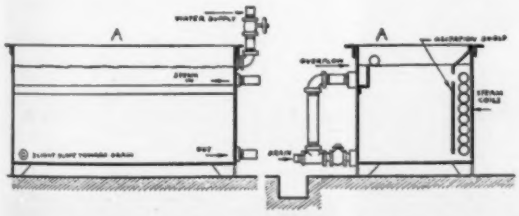
The method most widely used in heat-treating operations, for which Par-Kem Metal Cleaners were primarily formulated, is that which employs a hot-water solution of an alkaline metal cleaner. This method involves three general types of cleaning:

1. **Cleaning in power washers.**
2. **Cleaning in still or agitated tanks.**
3. **Cleaning electrolytically.**

The metal cleaners used for all three types of cleaning are basically the same. They are mixtures of alkalies and alkali salts—principally caustic soda, soda ash, phosphates and silicates—with or without a wetting agent added to improve emulsifying action.

The effectiveness with which the finished mixture performs its primary function of dirt removal depends upon which of these basic materials are used and in what proportions they are combined.

POWER WASHERS—With power washers, in which the cleaning solution is agitated by mechanical action, temperatures of 170-200°F. are recommended for alkaline cleaners, 140-160°F. for emulsion cleaners. In either case, only low concentrations of cleaner are required . . . which makes the power washer not only faster but somewhat more economical than other types.



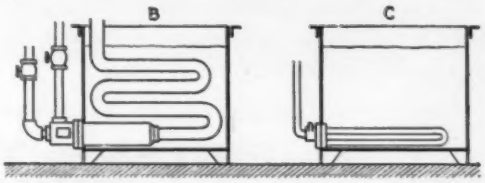
A typical steam-heated tank with overflow and agitation shield. Additional agitation may be obtained with propeller-type agitator, steam jets, or by mechanical or hand agitation of the work.

SOAK TANKS—Soak tanks require a somewhat higher concentration of cleaner than power washers, with temperatures of 180-212°F. With this type of equipment, heat and agitation are essential. The latter is provided by keeping the solution at a rolling boil, by blowing steam through the solution, or by using a mechanical or hand-operated type of agitator.

ELECTROLYTIC CLEANING—In electrolytic tanks, agitation is achieved by the evolution of gases generated by the electrochemical reaction that takes place at temperatures of 160-212°F. This type of cleaning involves three methods: cathodic, anodic, and a combination of the two.

In the first, the work is the cathode. This causes considerably more gassing and therefore better agitation. However, it has the disadvantage of plating the work with any metallic impurities that may be present.

When the work is the anode, as in the second method, the danger of plating is eliminated but the surface of the parts is subject to attack. The third method is to clean cathodically first, then switch to anodic cleaning.



Cleaning tanks may also be heated by gas, as in Figure B . . . or by electricity, as in Figure C. Same means of agitation are employed as in the steam-heated tank.

EMULSION CLEANERS—Emulsion cleaners combine high solvency with good emulsifying properties. They are particularly effective in removing heavy deposits of oil, grease, slushing compounds, etc. They also provide temporary protection against rust.

Since emulsion cleaners mix readily with water, petroleum solvents and aromatic solvents, they are suitable for a wide range of metal-cleaning applications and may be used with any type of equipment, including manual cleaning.

PAR-KEM CLEANER CHECK-LIST

Par-Kem Cleaner No. 7, medium duty all-purpose cleaner for use in soak tanks.
Par-Kem Cleaner No. 9, designed for power washers, also suitable for soak or electrolytic tanks.
Par-Kem Cleaner No. 11, heavy-duty cleaner for use in soak tanks. May also be used in electrolytic tanks.
Par-Kem Cleaner No. 15, an efficient combination of alkalies and synthetic detergents for use in tanks or power washers. Especially suitable for cleaning oily work.
Par-Kem Emulsion Cleaner, for power washers, soak tanks or as a solvent cleaner.

For detailed information on Par-Kem Cleaners and their application, send coupon for Technical Bulletin No. E-1, or write for an analysis of your specific problem to PARK CHEMICAL COMPANY, 8074 Military Ave., Detroit 4, Michigan.

PARK CHEMICAL CO.
8074 Military Ave., Detroit 4, Mich.

Please send your technical bulletin No. E-1 on Par-Kem Metal Cleaners to:

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METAL & THERMIT CORPORATION

GENERAL OFFICES: RAHWAY, NEW JERSEY

PSC's All-Sheet Construction Adds to Furnace Tube Life

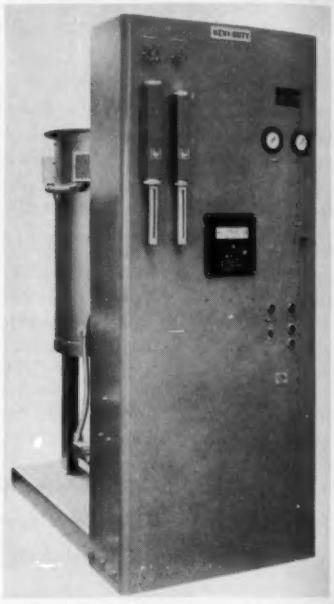
Experience of users shows much lower frequency of burn-out, with tube life extended up to 100%. In PSC tubes, precision-welded bends are of same metal and thickness as the legs. The continuously smooth walls result in uniform flow of gas, and reduce the carbon build-up and bend burn-out, which commonly result from the rough interiors of cast alloy bends. Lighter than cast by 33 to 50%, PSC radiant tubes cost less initially. Any size, shape or alloy.

Send for Heat-Treat Catalog

THE PRESSED STEEL CO. • Wilkes-Barre, Pa.

treating processes:

Bright hardening of medium and high carbon steels and alloy carbon steels



Bright hardening of high speed steels

Annealing and Normalizing

Bright copper brazing

Sintering and powder metallurgy processes

Carrier gas for carburizing and carbonitriding

For further information circle No. 9

COMMERCIAL BRAZING FURNACE

Installation of one of the largest commercial brazing furnaces in the West was announced today by Metallurgical Consultants, Inc., Maywood, Calif.

The electrically-heated furnace, 7 feet high and 6 feet in diameter, will provide controlled temperatures up to 2250° F. and handle parts as large as 40 inches in diameter and 36 inches high, according to John J. Lawless, Jr., vice president.

It was engineered and built to the firm's special requirements by Pacific Scientific Co.

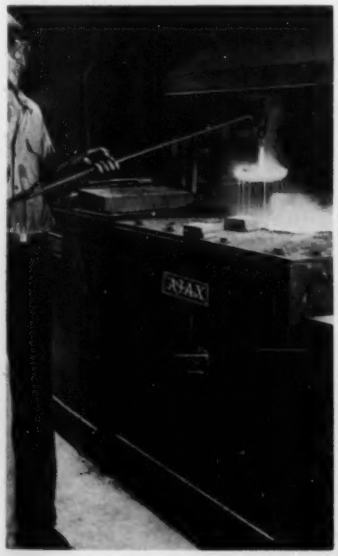
Lawless said the new equipment will be put into operation immediately on nitriding, a heat-treating process which enriches nitrogen content at the surface of steel parts and increases hardness and resistance to abrasion.

About 40 percent of the furnace's capacity will be reserved for highly technical operations such as hydrogen brazing of jet engine parts, annealing of high-nickel steels and vacuum outgassing, a process which reduces hydrogen content of titanium to increase ductility.

For further information circle No. 10

SALT BATH FURNACES

The Pipe Machinery Company, Wickliffe, Ohio, is currently heat treating high speed steel cutting tools within 1½ points Rockwell hardness on a production basis. In a single year, the firm has turned out over a quarter million pounds of tools and gages, about 90% of which were high speed steel. Tools are treated in salt bath furnaces manufactured by Ajax Electric Company, Philadelphia, Pa.



The Pipe Machinery Company has used salt baths since 1940. They feel that heating by salt has contributed significantly to the high quality of their tools.

For further information circle No. 11

Trusting
your profits to
"pot luck"?
With pressed steel pots,
sudden failure never strikes
Cast steel or alloy pots can fail suddenly at any one heating. When and where this blow strikes your profits is a matter of luck. The most careful visual inspections won't reveal the hidden flaw that results in major damage to brickwork, burners, and controls.
Eclipse Pressed Steel Pots cost only one-third as much as cast pots . . . yet cannot turn suddenly defective! No defective steel survives the stresses of drawing. Switch to pressed steel pots and you switch to scheduled pot maintenance that puts your profits on a predictable basis. What's more, Eclipse pots weigh only half as much and have higher thermal conductivity! That means substantial fuel savings and faster, better controlled heating.
Eclipse Pressed Steel Pots are formed from highest quality firebox open-hearth mild steel, from the heart of the ingot, with a perfectly uniform 3/8-in. section. They're practically impervious to corrosion. Write for illustrated catalog and price list — 78 standard pots available immediately from stock! For lead, salt, cyanide, oil tempering, metal melting.
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INDUSTRIAL
COMBUSTION
DIVISION

NOW Available...

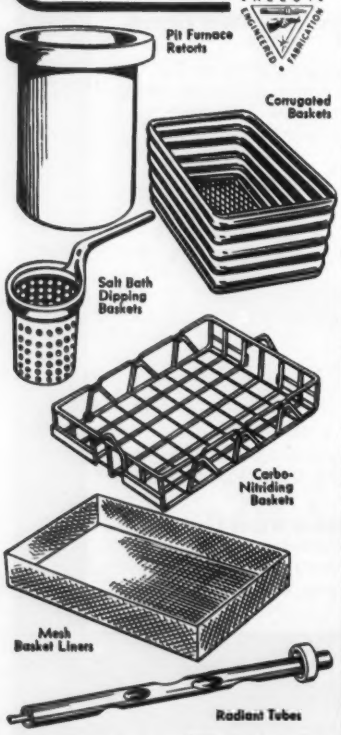
MISCO Heat-Treating Tools *from Stock!*

MISCO heat-treat process equipment is engineered and fabricated by qualified specialists in the field of heat-resisting alloy materials.

With a wide variety of job-proven heat-resisting steel products available for immediate delivery, Misco Fabricators provide a real service to heat-treaters, who no longer need carry an expensive inventory of equipment.

Remember, whatever your need, Misco Fabricators offer sound, economical designs in the best metal for your purpose. It pays to do business with Misco Fabricators—Specialists in Nickel-Bearing Alloy Fabrication.

• ALLOY • ENGINEERED FABRICATION



Special Equipment Designed and Made to Order

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Designers, Builders, Fabricators of Heat-Resisting Alloy and Stainless Steel Equipment

2420 WILLS AVENUE • MARYSVILLE, MICHIGAN

TELEPHONE YUKON 5-6191

LETTERS TO THE EDITOR

Gentlemen:

Would you be so kind as to place our College of Engineering Library on your mailing list to receive your magazine *Metal Treating?* Dr. W. R. Upthegrove, Chairman of our Metallurgical Engineering Department, asked that I write you for this magazine.

(Mrs.) Louise M. Sizemore
Engineering Librarian
The University of Oklahoma
Norman, Okla.

Dear Editor:

I would appreciate your placing my name on the distribution list of "Metal Treating" magazine.

As project engineer in charge of Heat Treat Development, I find your publication very informative and valuable in my work. Thank you.

M. S. Miller
Project Engineer
Curtiss-Wright Corporation
Wright Aeronautical Division
Wood-Ridge, N. J.

Dear Editor:

We receive your "Metal Treating" regularly and find it a most interesting and up-to-the-minute publication. You are certainly to be commended for it.

Since it keeps our heat treating interests aroused, we are at present seeking information on oil quenching equipment. We make reference to vigorously agitated, controlled elevated temperature units, particularly the self-contained type.

If you know of any manufacturers of such equipment, we would appreciate very much having their names and addresses.

Irvin Schaible
Heat Treat Supervisor
The Apex Machine & Tool Co.
Dayton, Ohio

Dear Editor:

I have recently had the opportunity of reading several issues of your magazine, "Metal Treating". I would like to be placed on your mailing list as I feel the articles on heat treating are very worthwhile.

J. D. Carey
Metallurgical Engineer
Welding Process Engineering
General Electric Company
York, Penna.

Dear Sir:

Occasionally it is possible for me to secure a copy of "Metal Treating," and I have found it to be a very interesting publication.

You and the Metal Treating Institute are to be commended for bringing such useful information to ordinary Heat Treaters like myself.

Would it be possible for you to place me on your mailing list so that I may receive it regularly.

Geo. M. McMahan
Sub-Foreman
Heat Treating Dept.
Hughes Tool Co.
Bellaire, Texas

Dear Sir:

We have been asked to obtain reprints of the following articles which appeared in the March-April 1957 issue of your publication, "Metal Treating."

1. "How to Select the Proper Heat Treating Equipment" by Carl F. Burling, Sales Mgr., Lindberg Engr. Co.
2. "Heat Treatment of Titanium" by P. D. Frost, Battelle Memorial Institute
3. "Vacuum Melting & Annealing" by Roger Giler, Ind. Htg. Dept. Westinghouse Electric Corp.

We would like to have six copies of each article. If there is a charge for supplying reprints, please send an invoice covering this expense to my attention.

Joseph S. DeMaio
Assistant Advertising Manager
The Carborundum Company
Niagara Falls, N. Y.

Dear Editor:

Would it be possible for you to add our name to your mailing list for the publication, "Metal Treating"?

We feel it would be an addition to our library.

Marjorie Leach
Librarian
Vickers Incorporated
Detroit, Mich.

Large Stocks of One-Piece Elements. You get quick deliveries of Norton "Hot Rods" — on short notice. Also, most popular sizes of these CRYSTOLON heating elements — like the sizes shown in this section of the Worcester stockroom — are now made in the new, one-piece construction — with no welds. This assures greater strength and uniform straightness throughout each rod.

Greatly Increased Strength. Ever since they were first produced "Hot Rods" have been endorsed by users for outlasting other non-metallic heating elements up to 3 to 1. Today, the new one-piece rod, made in most popular sizes — and soon available in all sizes — is twice as strong in standard cross-bending tests.

One-piece "HOT RODS" now ready for immediate delivery...famous for long life and economy

CRYSTOLON heating elements bring you extra advantages for better performance and bigger savings*

Straighter Than Ever. Throughout the entire length of a one-piece, non-welded "Hot Rod" there isn't the slightest bulge in the surface. So, when you insert them into the openings of your furnace or kiln you can be sure there'll be no binding due to uneven diameters.

Scientifically Safe Packaging protects "Hot Rods" even more thoroughly than delicate household glassware or china. They're packed shockproof to reach you unbroken.

"Hot Rods" are a typical Norton ℞ — an expertly engineered prescription for greater efficiency and economy in electric furnaces and kilns. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Most popular sizes are non-welded and interchangeable with your present rods.

You save in element costs because you use far less "Hot Rods." Also, their more uniform heating quality, due to their slow, evenly matched rate of resistance increase, helps you protect product quality and maintain a smooth production flow. For further facts on "Hot Rod" advantages send for booklet *Norton Heating Elements*, NORTON COMPANY, Refractories Division, 630 New Bond St., Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

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MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

AUTOMATIC LOADERS

A bulletin describing their new line of "Man-O-Steel" automatic loaders for heat-treat furnaces, plating lines, and continuous tumbling has been prepared by the Michigan Crane & Conveyor Company, Detroit. Mich.

The loader has had a spectacular acceptance to date, says the manufacturer. Users report increases in furnace production up to 100%, practical elimination of rejects from over- or under-heating, and savings in man-hours up to 80%.

The new loader will deliver 500 to 5,000 pounds of small stampings, screw machine parts, or even castings and forgings up to 14 per hour. It is further stated by the maker that feed rates will not vary more than 5%.

For further information circle No. 12

INERT ATMOSPHERE GENERATOR

A new bulletin outlining Gas Atmospheres, Inc. new inert gas system has been published. It includes flow charts and cost analyses of the system and depicts typical installations in food, petrochemical and metallurgical industries.

For further information circle No. 13

METAL CLEANER

A general purpose cleaner to remove oils from steel, brass and base metals is fully described in a technical data sheet, a three-page usage and instruction sheet prepared by MacDermid Incorporated, Waterbury, Conn. Called Metalex W Special, the cleaner is mildly alkaline and has a high percentage of wetting agent. Especially compounded to counteract hard water effects, it is a free-rinsing cleaner and tolerates prolonged transfer periods. It can be used as a soak, direct or reverse current cleaner, and activates bright nickel plate or buffed nickel before chrome plating.

For further information circle No. 14

(Continued on page 42)

General Alloys' Radiant Tubes

built to last and last!

General Alloys' Radiant Tube Assemblies combine castings and fabrications to obtain the best features of each for optimum performance and service life.

The cast return bends give uniformity and extra strength at the area usually susceptible to early failure. The fabricated straight sections are light weight and provide maximum efficiency for heat transfer.

Special design combines casting and fabrication for maximum service life and efficiency

General Alloys combination cast and fabricated Radiant Tube Assemblies are available in many types of heat and corrosion resistant alloys, in a wide range of shapes and sizes to meet your specific requirements.

Extensive experience in high alloy castings and fabrications, together with modern production and testing facilities, is your assurance of superior results and satisfaction.

Call or write for detailed information or quotes.

General Alloys

General Alloys Company • Fabricated Alloy Division

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Specialists in high alloy castings and fabrications for 37 years

WANTED
BRINELL TESTING MACHINE
in good condition. Model HB3 or PH3 of Detroit Testing or equivalent.
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Wells Manufacturing Company
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FOR SALE
USED HEAT TREAT FURNACES
Late, Modern Equipment—Immediate Delivery
What are your requirements?
Write for our latest list.
PAPESCH & KOLSTAD, INC.
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Phone: Lincoln 7-6400

HEAT TREATING HINTS

DID YOU KNOW —

THAT A tool is worth only its weight in scrap until it has been properly heat treated.

THAT All tool steels should be tempered just as soon as the piece has cooled to where it can be comfortably held in the bare hand.

THAT Tool life can usually be increased by stress relieving after grinding at a temperature slightly below the tempering temperature.

THAT Tools made of air hardening or high speed steels are straightened during the quench between 700° and 500°F.

THAT If severely machined pieces are stress relieved before finish machining, much distortion can be corrected before hardening and while the steel is still at a lower hardness.

THAT All tools should be fully annealed before hardening.

THAT A temperature of about 1200°F. is adequate for stress relieving tools before hardening.

THAT Preheating tool steels is desirable to minimize distortion—minimize decarburization or carburization—reduce thermal shock—avoid rupture between large and small sections and reduce time at high temperatures.

THAT If unusual size change is experienced after hardening, tools should be retempered before other corrective steps are taken.

THAT Stress relieving reduces distortion and cracking during heat treatment.

THAT Shrinking of air-hardened steels is a result of carburization or overheating.

THAT Where atmosphere controlled furnaces are not available, tools are packed in dry clean burnt cast iron chips or 6 to 8 mesh size spent pitch coke.

THAT The manufacturers' recommended allowance for machining before heat treatment should be followed to minimize distortion—obtain uniform surface hardness—reduce cracking during heat treatment—achieve maximum service life.

Source—Crucible Steel Company of America

New **RECIPROCATING HEARTH FURNACE**

Patent 2,671,654

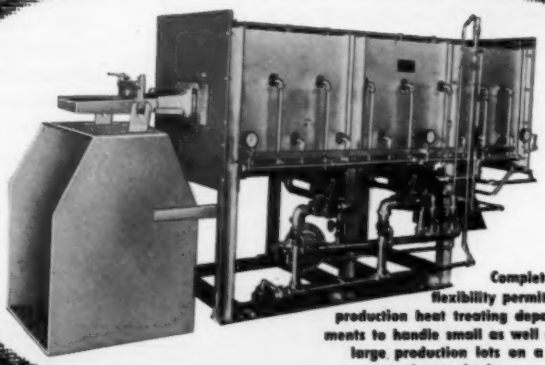
Carburizing, case hardening, "Ni-Carb" ammonia-gas carburizing, clean hardening, etc. of parts ranging from balls for ball point pens to heavy forgings can be accomplished in the same model without any modification.

Newly engineered fully automatic feeding device eliminates costly work handling.

Individualized treatment assures uniformity of product. Each piece is individually heated, subjected to the atmosphere and quenched. Disadvantages of batch heating and quenching are eliminated. Work can be observed throughout the processing cycle. Only the work enters and leaves the furnace. Baskets, trays, chains and other troublesome mechanisms are eliminated.

Sizes in production capacities up to 600 pounds per hour. Representatives in principal cities.

By AGF Pioneers, the originators and builders of Reciprocating Furnaces since 1921. Features include stationary muffle and complete atmosphere control.



Complete flexibility permits production heat treating departments to handle small as well as large production lots on a continuous basis.

Send your Bulletin 850 which will help us produce a quality product at lowest cost.

NAME..... TITLE.....

COMPANY.....

ADDRESS.....

AMERICAN GAS FURNACE CO.

808 LAFAYETTE STREET — ELIZABETH 4, N. J.

TOTAL RADIATION PYROMETERS

(*Continued from page* 10)

In the primary metal industries, these pyrometers have applications in recording and controlling the temperature of the rolls in hot roll mills; measuring temperature of steel travelling through an annealing furnace; measuring and controlling induction heating of alloy billets; measuring temperature of magnesium

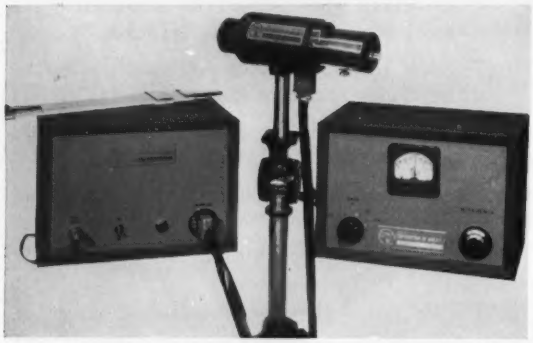


Fig. 2—Type IR-2 pyrometer system showing power supply (left), pyrometer pickup head (center), and amplifier unit (right).

sheets and steel bars; and in other processes where the metal is in motion or is inaccessible.

These total radiation pyrometers are also employed in fabricating metal products. Many other industries are also exploring applications of infrared pyrometers for remote heat detection and control.

Every object at a temperature above absolute zero emits electro-magnetic radiations over a wide frequency range. The specific peak wavelength of this energy is a function of the temperature of the object. As the temperature increases, there is a corresponding decrease in the wavelength of the maximum radiation. Between absolute zero and 1000°C, over 99.9% of the radiation occurs in the infrared region. Fig. 1 shows the relative energy versus wave length for blackbodies at temperatures between 20°C and 920°C.

These curves are derived from three bases for relating total radiation to temperature: the Planck equation defining the spectral distribution of energy; the Wien displacement law, and the Stefan-Boltzmann law of total radiation. Note that 75 per cent of the total energy, represented by the area under the curves, is on the long wave-length side of the radiation maximum, and that most of the energy is at wavelengths greater than one micron. For example, at 1,000°C, less than 0.5% of the total energy is below that wavelength. At lower temperatures, considerably less total energy is available, and the distribution shifts to longer wavelengths. To utilize most of the available energy, a pyrometer should detect the energy from 1 to 12 microns or more. In some cases, such as the determination of total emissivity, a response to 25 microns is required for accurate results.

Infrared radiation behaves essentially the same as visible light. It is on these principles that the operation of Servotherm* pyrometers is based.

The Servotherm IR-2 radiation pyrometer, shown in Fig. 2, comprises a pyrometer head, an amplifier and a power supply. This general purpose unit, designed especially for industrial applications, covers a wide range of temperature variations, from 60 to 1300 degrees Centigrade. It maintains calibration under the ambient conditions encountered in manufacturing plants. The output can be fed directly into proportional automatic control systems.

A simplified section of the pyrometer head is shown in Fig. 3. A partial schematic of the amplifier and power supply circuits is shown in Fig. 4. Basically, this is how the system works.

Incoming radiant energy, which is a function of temperature, is collected by the lens. This lens is made of Servofrax glass which possesses excellent physical, chemical and optical properties for infrared detection and control.

After interruption by the mechanical chopper at a 15 cycles per second rate, the incoming radiant energy is focused on the detector which is a Servotherm thermistor bolometer. This energy is compared with similarly interrupted energy from an internal reference radiation

* *Registered Trademark of Servo Corporation of America*

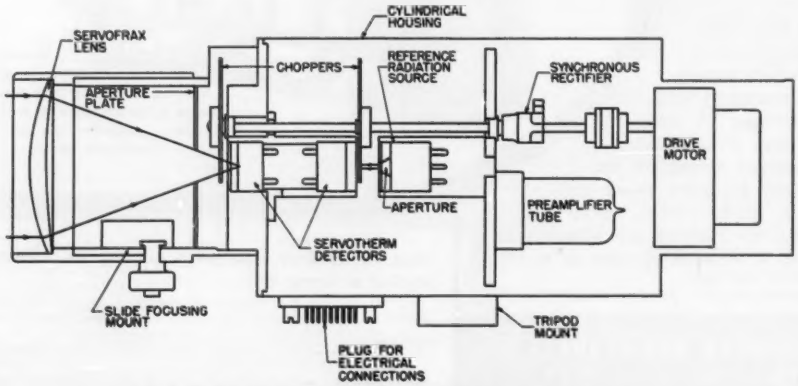


Fig. 3—Simplified sectional view of type IR-2 pyrometer head.

source by means of a second detector, bridge-connected with the first. The bolometer bridge is biased with direct voltages balanced to ground. The cyclic interruption of the energy produces cyclic variations of the bolometer resistances. Any difference in energy levels between incoming and reference radiations produces an alternating microvoltage output from the bridge to the preamplifier grid. The phase of this output voltage depends on which radiation level is higher, that of the target or that of the reference, since the radiation from either chopper is itself equal to the ambient level of the pyrometer head.

The output of the bolometer bridge is amplified by the preamplifier and main amplifier units. It is then rectified by a synchronous rectifier unit on the chopper shaft. This produces a direct potential that is sensitive to the energy levels; i.e., a source hotter than the reference produces a positive voltage output, and a colder one, a negative voltage output.

The internal reference source is always used to null the incoming radiation, making it possible to utilize full amplification to obtain high differential sensitivity at all times. Once the pyrometer is set for a given temperature, any small deviation from that temperature appears as a relatively large voltage output which may be employed for manual indications and control or as the input signal to an automatic control system. Once set at a given temperature, the system response time is approximately 250 milliseconds. The time required for the reference source to stabilize at a new temperature setting varies from about 30 seconds to five minutes depending upon the initial and final conditions.

The standard model pyrometer system has a field of view of one degree square. The lens focuses from 1.5 feet to infinity. Accessory lenses are available.

For application to an industrial process, the instrument is calibrated under controlled conditions to obtain required measurement accuracies. A typical example is the use of the pyrometer in manufacture of sheet film. This process requires careful control of the temperature of film moving at high speeds. Thermocouples or thermistors cannot accurately show the film temperature. However, a stationary piece of film may be set up under controlled temperature conditions, and the pyrometer calibrated against this piece. This calibration may then be transferred to the film in process.

Such a transfer calibration is usually preferable to attempting a relationship to a standard blackbody calibration. The latter, however, is useful when emissivity factors are to be determined, and under other special conditions.

A specimen calibration curve for the type IR-2 system is shown in Fig. 5. This was taken on a blackened hot plate. The surface temperature was measured with a small thermocouple located at the center of the field of view. The calibration is for the full aperture of the collecting lens, and the standard reference source. Higher temperatures are read by stopping down the

(Continued on page 43)

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MANUFACTURERS' LITERATURE

(Continued from page 38)

BOOKLET ON LITHIUM

"Presenting Lithium", a fifteen-page tabbed booklet, has just been issued by the recently formed American Lithium Institute, Princeton, New Jersey. The booklet describes the properties, uses, research potentials and availability of lithium and its unique compounds and discusses the function of the Institute.

For further information circle No. 15

CONTROL INSTRUMENTS

A digest of specifications of instruments and controls manufactured by The Hays Corporation, Michigan City, Ind., is offered in their new 12-page condensed catalog. Instrumentation problems dealing with pressure, flow, temperature, level, and gas analysis are discussed.

For further information circle No. 16

HYDRAULIC DESCALING EQUIPMENT

A revolutionary new type of hydraulic descaling equipment is described in a 36-page, two-color illustrated catalog published by The Commercial Shearing and Stamping Company, Youngstown, Ohio. The catalog describes and pictures the operating principles and features of Commercial's new "Hydra-Jet" descaler equipment for removal of scale from bars, slugs, and rolled mill products prior to hot working. Complete explanation is given of new features including attainment of high pressures by an oil pump rather than a more expensive high-pressure water pump, and use of a jet ring or jet bar to produce a continuous sheet of high-pressure water, which is said to give best scale removal with minimum water consumption and heat loss compared to the less efficient patterns from spray nozzles.

For further information circle No. 17

CRACKING HAZARDS

A new eight-page brochure discusses means of eliminating cracking hazards in the manufacture of tools and dies. The booklet, published by The Carpenter Steel Co., Reading, Pa., gives detailed information on design, how to make the tool, heat treatment and selecting the steel. It is well illustrated with closeup photographs of tools and dies having cracks of various kinds. The causes are then explained along with recommended ways to avoid the cracks.

For further information circle No. 18

CONVERSION FACTORS CHART

A reference table for engineers and other executives in wall chart form has been published by Precision Equipment Co. This Conversion Chart is useful for engineers, shop men and executives.

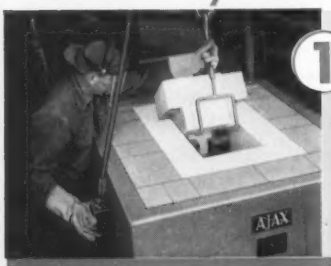
Included are common conversions such as inches to centimeters or watts to H.P. as well as many conversions that are difficult to locate in reference manuals. (Some examples are atmospheres to Kgs/sq. cm; cm/sec to miles/hr; cu. ft. to liters; microns to meters; quintal to lbs., etc., etc.)

For further information circle No. 19

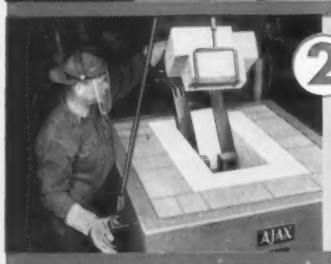
(Continued on page 49)

CHANGING AJAX SUBMERGED ELECTRODES IS

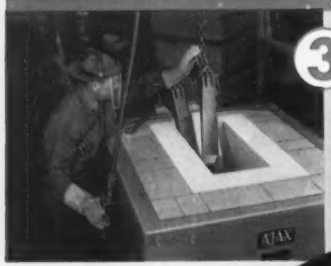
easy as 1-2-3!



1 **A closely-fitted tile block on top of the furnace seals the new Ajax REMOVABLE* submerged electrodes from air. Lifting the tile exposes electrodes for fast, easy replacement, even by unskilled labor.**



2 **Note that electrodes enter furnace from the top and slant into the bath. There are no openings below the salt line. With the tile now lifted, the electrodes are freely accessible for fast replacement.**



3 **Lift electrodes out from the top! Change them in an hour or less per pair! No lost production time. Replacements can often be made while salt remains molten. Pot life is vastly increased because pot is not torn down in replacing electrodes.**

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Pioneering Salt Bath Progress

(*Continued from page* 41)

lens. With the reference set at 100 degrees Centigrade, the average differential sensitivity is about ∓5°C for full output. The incremental sensitivity is less than 0.25°C, and the over-all control accuracy of a typical installation is better than 0.1°C.

One further consideration is of interest. In many continuous-flow processes, an absolute temperature reading is not needed. The essential requirement is to be able to reproduce a process condition over a period of time. For such conditions of operation, the IR-2 system will give entirely satisfactory service over long periods without recourse to temperature calibration.

The following is a description of the components of the IR-2 pyrometer.

Optics

Arsenic trisulfide glass (Servofrax) was selected for the lens. As shown in Fig. 6, this glass has good transmission in the 1-to-12 micron region. It is the only far infrared transmitting glass in commercial production. It does not require special handling, is stable and retains its shape, and is impervious to most chemicals. It can be cleaned in ordinary tap water and dried with common lens tissue.

The f/1.25 Servofrax meniscus lens is two inches in diameter. It was designed for minimum spherical aberration and to give the desired one degree field of view. By both the use of shorter focal length and increasing the detector dimensions, fields of up to five degrees can be achieved. Smaller fields may be obtained by using a lens with a longer focal length.

Detectors

The detector used in the IR-2 pyrometer is constructed of very thin flakes of electronic semi-conductor material with a high negative temperature coefficient of resistance. Housed in hermetically sealed capsules, they combine time constants of two milliseconds, excellent sensitivity, and uniform spectral response with ruggedness and long-term stability.

The sensitivity of a detector is defined as the volts output per watt of energy falling on a unit of detector area. The maximum utilization of the detector sensitivity is determined by the relation between the chopping frequency and the response time of the detector. For a typical detector as used in the IR-2 system, 1 mm. x 1mm. x 0.01 millimeter thick, the sensitivity is 250 volts per watt of incident radiation. The 15 cps interruption rate used in this system permits utilization of practically all of the available sensitivity.

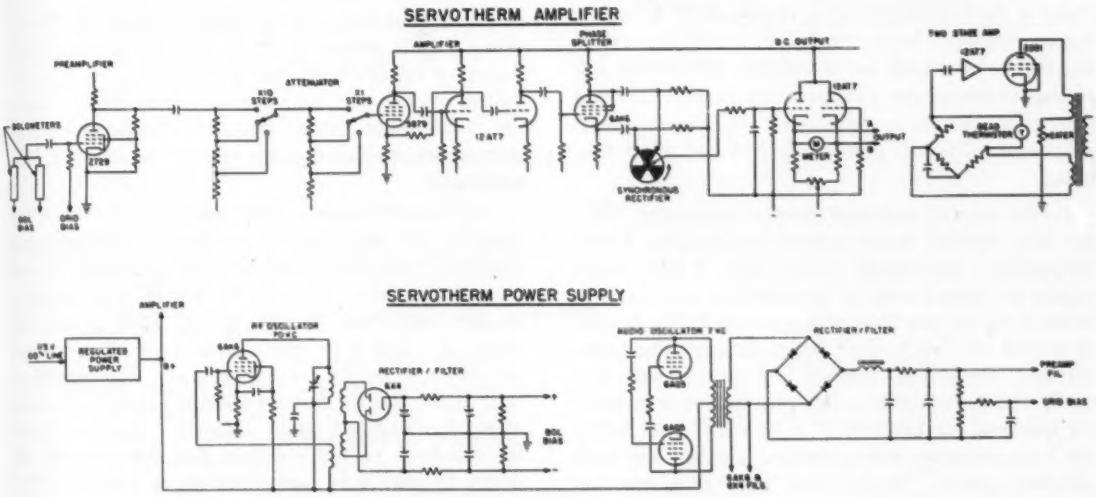

Fig. 4—Partial schematics of amplifier and power supply units.

Electronic System

Extreme care in the design and construction of the electronic system is necessary to utilize fully the signal

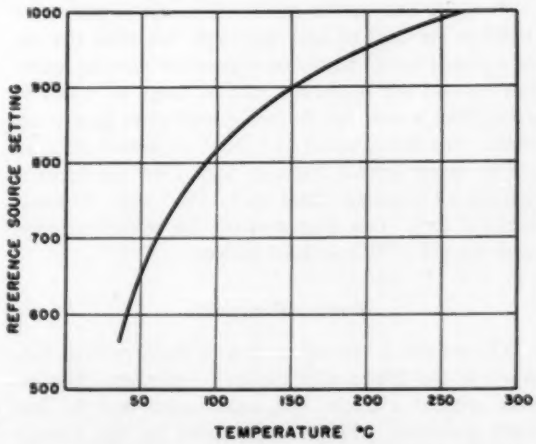

Fig. 5—Typical calibration curve for type IR-2 pyrometer with lens wide open. Higher temperatures are measured by reducing lens aperture.

(*Continued on page* 47)

(*Continued from page* 8)

nace rails in place of the more conventional nickel-chrome alloys. Research in combustion techniques have been fruitful in furnishing some of the answers to more efficient heat transfer which, in turn, improves the uniformity of heat treating operations and increases unit capacities of both batch and continuous furnaces.

Possibly the most important trend in the industry today is the placing of fuller responsibility upon the furnace builder. Many purchasers in 1957 required the builder to install his equipment, put it into operating condition and guarantee the results. This requirement was made particularly by the large-firm purchasers who were particularly cost and profit conscious.

In the area of induction heating equipment, there are also decided trends toward automation, higher temperatures and larger heater sizes. Larger metal masses are being heated by the induction process; there seems to be no size limit within reason in the heating of carbon and alloy steel, brass, copper, aluminum, titanium, magnesium, uranium and other metals. Recently, the largest billet heater ever built was installed for handling one hundred 7″ x 7″ x 14″ steel billets per hour, complete with automatic handling and temperature control. Similar units have been installed for 30″ long by 12″ diameter aluminum billets.

The "building-block" principle in the manufacture of modern capital equipment has gained momentum in 1957. Ford Motor Company has spearheaded this new evolutionary concept. One induction heater manufacturer recently developed a new line of heaters featuring building-block construction that will permit ready conversion to other heating operations after the equipment has served the purpose for which it was originally purchased.

Probably one of the most unique developments of 1957 in the field of heat treatment has been the use of a closed circuit television system for viewing activities beyond the operator's natural range of vision in controlling a new line for wide steel plate heat treatment. The line consists of a 135′ hardening furnace, a 150′ draw furnace and a 45 foot, 2500 ton pressure quench all handling plates up to 156″ wide, 2″ thick, and 45′ long. One man controls the entire operation with the aid of his television system.

Future Prospects

The industrial heating equipment industry looks forward to the future with cautious optimism. The future, without a doubt, will demonstrate that the furnace purchaser will get even more for his furnace dollar than ever before. He will receive increased production and higher quality, and therefore an improved heat-treated product will result. A famous American industrialist once said that a firm requiring a new piece of machinery but which doesn't purchase it is paying for it anyway. The furnace builder will make this statement more valid in the future than ever before.

This idea will be demonstrated to all heat treaters to a remarkable degree in 1958. Heat treaters will recognize that obsolescence is not a loss which can be provided for out of income but is a cost far in excess of depreciation.

The economic breathing spell, as President Eisenhower calls it, setting in at this time will spur a greater degree of competition. The fruits of this competitive system of ours will invite progressive equipment builders to show even greater efforts in providing more production, more efficiency and more economical capital equipment.

The United States, which undoubtedly leads the world in its heat treating equipment facilities, will continue in the foreseeable future as undisputed champion in this field. This will be due in large measure to our competitive free-enterprise system which requires, if a firm is to remain in business, that product improvement be its continuing goal. The American heat treater and the furnace builders cannot ever coast along, free-wheeling style. They must continue to set the standards of the world in this indispensable industry by hard work and ingenuity. • • •

(*See Table on next page for summary*).

"WHAT SPECIAL HEATING JOB ARE YOU DESIGNING THAT INDUCTION COIL FOR?"

TABLE

INDUSTRIAL FURNACES, OVENS, AND RELATED INDUSTRIAL HEATING EQUIPMENT: VALUE OF NET ORDERS RECEIVED AND SHIPMENTS, 1956

TYPE OF EQUIPMENT	Net Orders Received ($1,000)		Shipments ($1,000)	
	Total (including exports)	Domestic	Total (including exports)	Domestic
Industrial heating equipment and parts	315,357	302,053	241,445[1]	230,363
Industrial heating equipment, excluding parts	281,549	269,133	210,209	200,048
A. METAL MELTING AND REFINING FURNACES:				
1. Ferrous, all types except cupolas and blast furnaces		9,559	5,021	
2. Cupolas		9,564	5,210	
3. Nonferrous, including holding furnaces		3,384	2,175	
B. FURNACES FOR HOT FORMING (FERROUS AND NONFERROUS):				
1. Furnaces for rolling mills (soaking pits, slab and billet, heaters, etc.)		58,971	18,531	
2. Furnaces for forging, forming, and extruding		1,663	1,434	
3. Metal processing and heat treating furnaces including vacuum type[2]	N	54,569	50,316	N
4. Furnaces for the glass and ceramic industries including lehrs and kilns	O	8,936	8,210	O
5. Miscellaneous	T	730	647	T
C. ELECTRIC FURNACES (EXCLUDING INDUCTION):				
1. Metal melting furnaces		5,950	5,495	
2. Metal processing and heat treating furnaces including resistance, vacuum, and bath-type furnaces[2]	A	28,355	27,197	A
3. Furnaces for the glass and ceramic industries including lehrs and kilns	V	1,754	1,351	V
4. Miscellaneous	A	186	184	A
D. ATMOSPHERE GAS GENERATORS, ALL TYPES UNDER 50,000 CFH:	I	5,397	6,292	I
E. INDUSTRIALS OVENS:	L			L
1. Fuel fired ovens		33,821	31,401	
2. Electric ovens	A	6,803	6,281	A
F. COMBUSTION EQUIPMENT FOR USE WITH ABOVE FURNACES AND OVENS:	B	12,010	12,215	B
G. INDUCTION FURNACES AND HEATING EQUIPMENT:	L			L
	E			E
1. Radio frequency types (including spark gap)		8,137	8,222	
2. Lineard motor generator self-frequency type		15,625	15,934	
H. DIELECTRIC HEATERS:		3,228	3,460	
I. OTHER TYPES:		491	633	
J. REPLACEMENT AND REPAIR PARTS SOLD SEPARATELY:	33,808	32,920	31,237	30,316

[1] Includes $109.6 million field erected and $131.8 million factory assembled.
[2] Includes annealing, brazing, sintering, porcelain enameling, carburizing, hardening, tempering, malleablizing, etc.

VACUUM METALLURGY

(*Continued from page 7*)

and gases, depending upon the workload, process, temperature, and the vapor pressure of the heater. Tungsten, molybdenum and tantalum are often used as heater elements due to their vapor pressures and refractory properties as compared to other possible materials of construction. Table I gives the vapor pressures of some materials as a function of temperature. Furnaces with carbon heaters can attain temperatures well in excess of 3632°F. However, carburizing effects limit their application.

A variety of types of refractory metal resistive heater vacuum furnaces are available. Heater elements are

TABLE I

Vapor pressure of some materials as a function of temperature in MM HG

	3272°F	3992°F	4712°F
MOLYBDENUM	1.4×10^{-6}	3.4×10^{-4}	1.7×10^{-2}
CARBON	2.9×10^{-8}	2.8×10^{-5}	4.4×10^{-3}
TANTALUM		5.4×10^{-7}	9.6×10^{-5}
TUNGSTEN		8.3×10^{-8}	1.7×10^{-5}

cylindrical in configuration. Their variation in construction includes: single turn sheets ("keyhole heater"), tandem single-turn units (to provide a longer cylinder), loops and windings of wire and rod, long tubes, and others. Their particular geometry, power dissipation and high temperature strength characteristics qualify them for many applications. High efficiency of operation is obtained by surrounding the heater element with multiple refractory metal radiation shields.

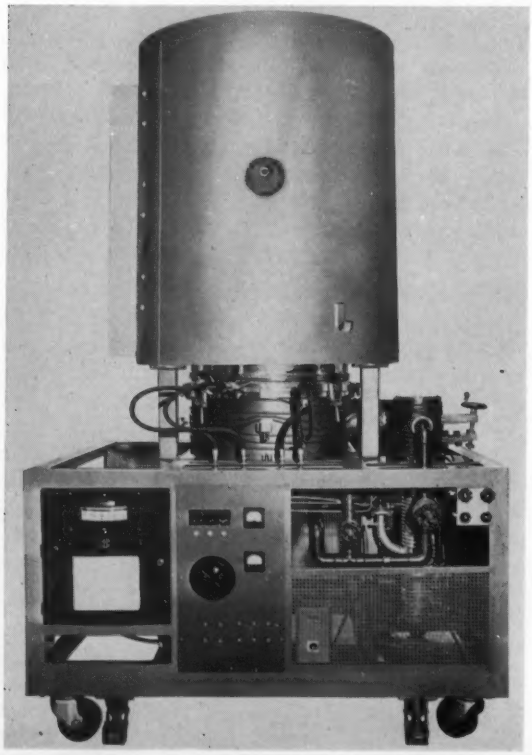

Fig. 7—A bell-type annealing furnace. Vacuum "bells" can be chilled by lifting off and removing the heating jacket and exposing the bell to air or water spray.

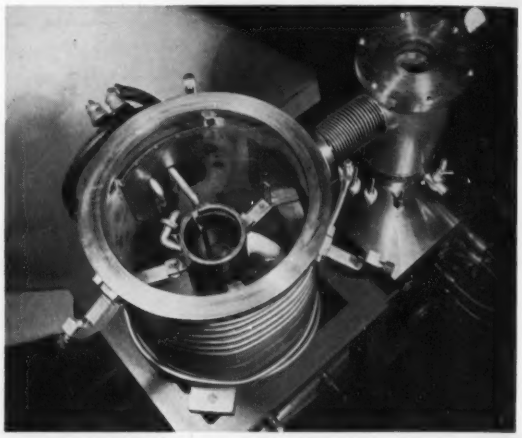

Fig. 8—A single-turn heater for vacuum brazing and sintering with the top radiation shields removed.

One popular type of heater for vacuum brazing and sintering work is a single-turn heater which is often constructed of molybdenum, tantalum or tungsten. Fig. 8 shows a picture of such an assembly with the top radiation shields removed.

Windings of molybdenum insulated by radiation shields and held in place with proper insulating refractories may also be used and are somewhat more flexible within the temperature range through which they are applicable. These heater elements will operate at temperatures up to 2912°F. and find wide use for melting, tilt pouring, sintering, etc.

Tubular heaters of tungsten and tantalum provide homogeneous high temperature zones (to 3992°F.) in cylinders about 2" diameter and several inches long. They are especially useful for the higher temperature meltings, sintering, alloying and also for growing single crystals by the Bridgeman method.

The electrical, mechanical, thermal and hot strength properties of graphite and carbon make them eminently suitable for use as high temperature components. Heater elements are constructed of hard grades of graphite, machined into spirals or cylinders. Porous grades of carbon are frequently used as thermal insulators in these furnaces. Very high temperatures (above 3992°F.) can be attained in these units, providing that carbon vapor can be tolerated.

(The concluding instalment will be published in the next issue.)

(*Continued from page* 43)

from the detectors. At the microvolt level, where these detectors operate, every precaution must be taken to avoid introducing electrical noise into the system. The detector bias must be noise free, grid and plate voltages must be well filtered, grid current must be at a minimum and the filament supply must be d-c. The use of non-microphonic construction and components is essential. Because of the proximity of the drive motors to the input circuit, grounding and shielding must have careful attention. These needs are met by the preamplifiers built into the pyrometer heads. Sufficient initial amplification allows use of a flexible shielded cable to the main amplifier unit.

The design of the main amplifier, Fig. 4, is conventional. Calibrated step attenuators permit positive reset to a calibration point. The 3-stage feedback amplifier with a gain of about 7,500, drives a phase splitter whose output is fed to the synchronous rectifier. The d-c output from the latter is RC-filtered and fed to

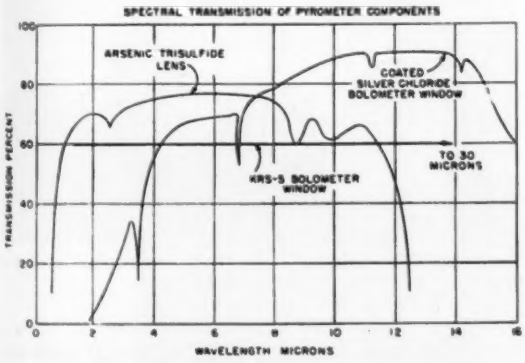

Fig. 6—Spectral transmission of pyrometer components.

a differential output stage. This combination was found superior to the use of a selective amplifier tuned to the chop frequency. It includes energy components in the detector output over the fundamental and reduces the speed stability problem of synchronizing motor speed to amplifier tuning. Since a negative supply is used for the cathode returns, the output is zero balanced and balanced to ground. Unbalanced output may be taken from terminal A to ground. The output stage will deliver about four milliamperes into 1,000 ohms and is designed to saturate on overloads to protect the recorder. Two special power supplies are contained to meet the requirements of well-filtered bolometer bias and preamplifier voltages. The bolometer bias supply uses a radio-frequency oscillator operating at about 70 kc. The oscillator output is fed to a carefully balanced rectifier-filter circuit. Since the plate supply to the oscillator is well regulated, output disturbances are minimized. Small residual variations appear balanced across the output. As the bolometer bridge is balanced, these tend to cancel out. Filament power for this supply is also derived from a regulated source. These precautions,

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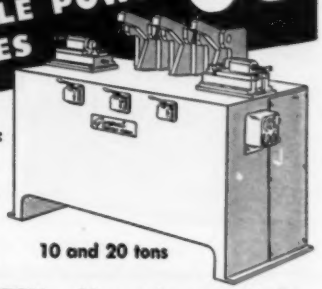

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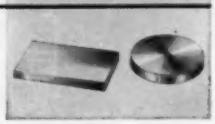

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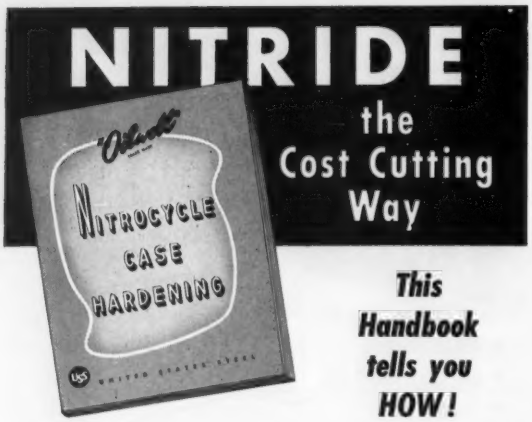

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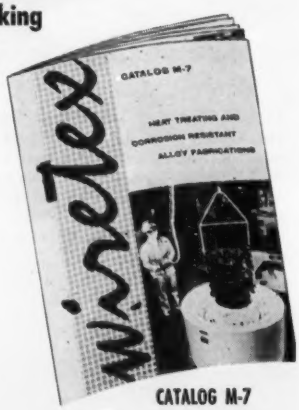


HEAT TREATING

- *Fixtures*
- *Retorts*
- *Baskets*
- *Muffles*
- *Trays*
- *Boxes, etc.*

PLATING

- *Baskets*
- *Tanks, etc.*

CATALOG M-7

Wiretex products are custom-made to resist acid, heat, abrasion or exposure... engineered in styles, alloys, weaves, sizes and quantities to meet your demands for lower operating costs, longer life and better performance. Call Wiretex!

For your copy write

WIRETEX mfg. co.
16 Mason St., Bridgeport 5, Conn.
Specialists in Processing Carriers Since 1932.

plus careful attention to reducing 60-cycle pickup and microphonics, make it possible to operate the biased bolometer bridge within six decibels of theoretical resistance noise for normal main supply variations from 105 to 125 volts.

The regulated filament supply uses a power audio-oscillator operating at 7 kc. Plate power for this unit is also well regulated. Part of the a-c output is used to power the bolometer bias oscillator and rectifier. The remainder is rectified and filtered and supplies d-c filament and grid bias voltages for the preamplifier.

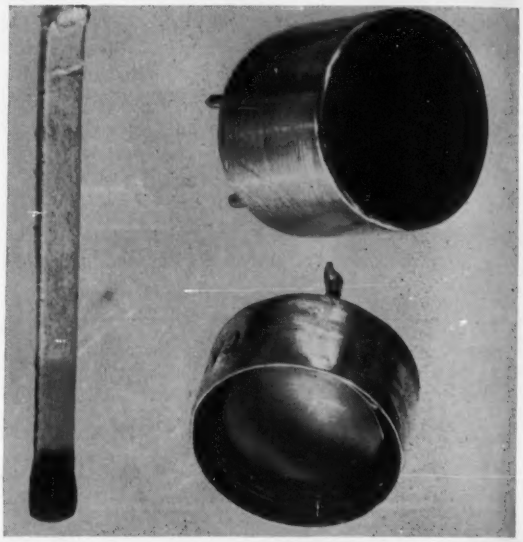


Fig. 7—Reference radiation source (left) and thermistor bolometer detector, as used in type IR-2 pyrometer head.

Reference Radiation Source

The reference source, Fig. 7, utilizes a small nichrome-wound heater element and an arsenic trisulfide window. The radiation temperature of the heater is sensed by a small bead thermistor which is bridge-connected with the control potentiometer. The bridge is excited at line frequency and its output after amplification is fed to a thyraton which controls the power input to the source. The amplifier phase shift is arranged to produce proportional output control at the balance point. Extremely stable control of the source is obtained in this manner.

An alternative source has been employed. This is a combination heater and liquid-cooled unit which allows operation down to and below ambient temperature.

Conclusion

Because of its flexibility, fast response, wide temperature range, its adaptability to the measurement of moving materials, and its remote operation, the total radiation pyrometer can be used to perform temperature measurement and control functions outside the operational capability of other instruments. It fills a specific need in industrial instrumentation for all fields where the measurement and control of temperature is a critical item in process control. • • •

MANUFACTURERS' LITERATURE

(*Continued from page 42*)

GAS GENERATORS

A new brochure describing the line of gas generators manufactured by The A. A. Straub Company, Cleveland, Ohio, has been announced. The four-page, two-color folder includes an interesting description of the three basic types of gas generators made by the company — Endothermic, Exothermic and Nitrogen, as well as a helpful table on the application of gas generators in eight major processing industries. Illustrations of alumina regenerative dryers and refrigerated gas coolers made by Straub are also included.

For further information circle No. 20

PNEUMATIC AND ELECTRIC CONTROLLERS

An 8-page, colored and illustrated bulletin picturing and describing the various Brown Electronik Controllers of the Minneapolis-Honeywell Company, Philadelphia, Pa., is available.

The bulletin maintains that no matter whether the process conditions are simple or complex, there is a Brown controller that will fit and is matched to the need of the individual process.

For further information circle No. 21

HEATING ELEMENT ALLOY

A new catalog-manual covering Chromel-D, a 35-20 nickel-chromium-iron heating element alloy recommended for use in controlled atmosphere furnaces operating at temperatures up to 1800° F. has been published by Hoskins Mfg. Co., Detroit, Mich.

The 12-page illustrated publication lists complete prices and specifications on the alloy as supplied in wire, ribbon and furnace strip form. Also included is a temperature-resistance curve, tables giving resistance tolerances and physical properties, and basic factors to be considered in designing furnace strip elements, rod elements and coiled wire elements.

For further information circle No. 22

SHEET AND STRIP DESCALING

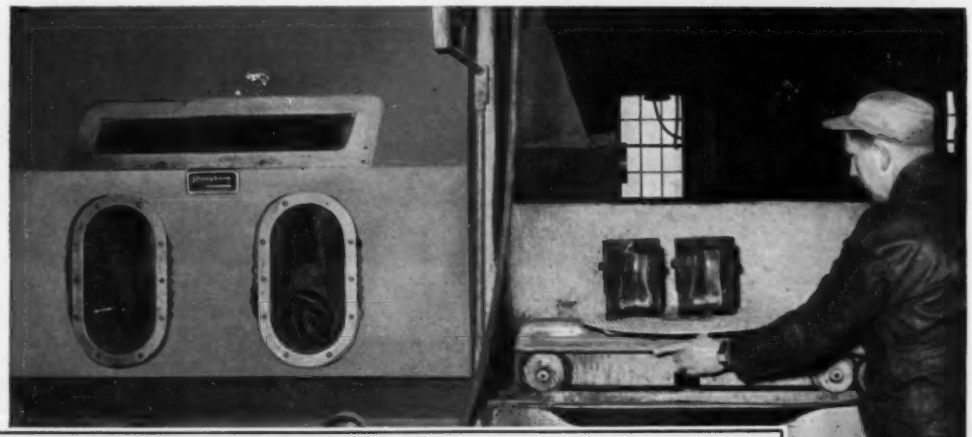
A six-company report, with detailed information on how each company has used mechanical descaling of steel to increase production and save money, has been published by Wheelabrator Corporation, Mishawaka, Indiana.

This 8-page booklet covers in detail the results of Wheelabrator mechanical descaling of carbon steel strip in a producing mill. It points out how a Wheelabator airless abrasive blast machine, combined with flash pickle, descales carbon steel strip at a rate that would have required approximately 250 feet of pickling tanks. Acid savings and savings in expense of acid disposal are also reported.

For further information circle No. 23

PRECIPITATION HARDENING STAINLESS STEEL

Electric Steel Foundry Company, Portland, Ore., a leading producer of stainless and high alloy stainless steel castings, has made a major contribution to the metals industry in the form of an extensive research program on 17-4ph precipitation hardening stainless



Pangborn Hydro-Finish cut cleaning time 50% in this plant

Paid for itself in only six months

Pangborn Hydro-Finish really paid off for this leading glass manufacturer. Cleaning quality increased moldlife 10% to 15% and total cleaning and polishing time was cut in half! The resultant savings paid for the machine in six months and represented a substantial weekly sum thereafter.

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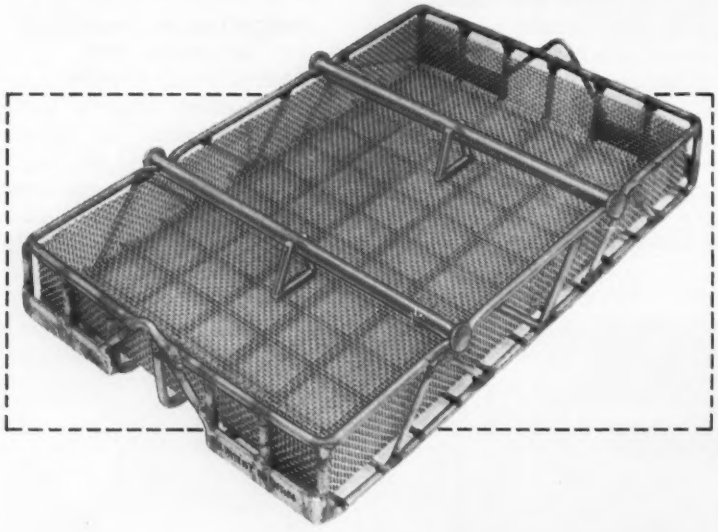
Today, through new design and use of air jet sluriators, Pangborn Hydro-Finish costs less originally, costs less to maintain and gives you easier handling and added efficiency. Write for Bulletin 1403 to PANGBORN CORP., 3600 Pangborn Blvd., Hagerstown, Md., *Manufacturers of Blast Cleaning and Dust Control Equipment.*

Pangborn

BLAST CLEANS CHEAPER

ROLOCK
FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

this Patented Rolock design
(U.S. Pat. No. 2807454, Sept. 24, 1957)
has changed the whole picture
of furnace tray performance



Originated by Rolock engineers, and now covered by patent, the unique construction of these round-rod sled-type trays has proved so successful that an increasingly large number of them are in service in Ipsen, Lindbergh, Eclipse, and other furnaces with this type of hearth.

Their performance has been exceptional, with hour life greatly extended (sometimes several hundred percent) and per-furnace-hour costs proportionately reduced.

These trays clearly demonstrate the following important advantages in service:—

- Travel easily and smoothly over hearth, with bottom bars acting as sleds.
- When used two-high, stacking bars provide adequate support and also prevent side-slide.
- Live-load to basket weight ratio often better than 10 to 1.
- All-Inconel construction with Rolock-quality precision pressure welding.
- Longer furnace hour expectancy than any other known tray design.
- Lowest cost per hour of use.

Why not enjoy this superior performance and worthwhile operating cost savings? Place your next order for trays with **Rolock**. Also send for catalog of other heat treating equipment.

SALES AND SERVICE REPRESENTATIVES FROM COAST TO COAST

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10RL57

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

steel. This is a continuing study, and to date the principal effort has been directed toward establishing the mechanical properties after various heat treatments. The results of this first phase of the study have recently been published.

The study includes compilation of mechanical properties after precipitation hardening at temperatures of from 800° to 1200° F. in 50° steps for both cast and wrought samples. In general the cast material compares quite favorably with the wrought alloy. Also included in the text are the various mechanical properties of cast 17-4ph in the as-cast and annealed conditions.

For further information circle No. 24

TITANIUM FACT FILE

Mallory-Sharon Titanium Corporation, of Niles, Ohio, has prepared a 24-page "Fact File" booklet on titanium as a handy information and reference for design, materials, and production engineers.

The booklet gives key data on titanium's advantages; physical, mechanical, and corrosion properties; metallurgy; machining; as well as production information on machining, forming, welding and heat treating. Each of these main subjects are broadly covered with brief comments on important points.

For further information circle No. 25

ATMOSPHERE CONTROL

A bulletin published by The Sentry Company, Foxboro, Mass., describes in detail their "Diamond Block Method" of atmosphere control in their electric heat treating furnaces for hardening all types of tungsten, molybdenum, cobalt, high speed steel and high carbon, high chrome steel.

Furnaces employing this automatic atmosphere control require no analysis nor regulation of furnace atmosphere and the work is completely free from any scale or decarburization.

For further information circle No. 26

METAL TREATING

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6025 West 66th Street
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Cincinnati, Ohio

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Marysville, Michigan
ROLOCK, INC.
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Fairfield, Connecticut
STANWOOD CORP.
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Chicago 39, Illinois
WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

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2420 Wills Avenue
Marysville, Michigan
THE PRESSED STEEL COMPANY
Wilkes-Barre, Pennsylvania
ROLOCK, INC.
1232 Kings Highway
Fairfield, Connecticut
STANWOOD CORP.
4825 West Cortland Street
Chicago 39, Illinois
WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

FLAME HARDENING

OHIO CRANKSHAFT COMPANY
4620 East Seventy-first
Cleveland, Ohio

FLOW MEASUREMENT

SELAS CORPORATION OF AMERICA
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Denver, Colorado
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Milwaukee 1, Wisconsin
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3570 Fremont Place
Detroit 7, Michigan
IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois
JOHNSON GAS APPLIANCE COMPANY
522 East Avenue
Cedar Rapids, Iowa
LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois
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Dresher, Pennsylvania
SURFACE COMBUSTION CORPORATION
HEAT TREAT DIVISION
Toledo, Ohio
YOUNG BROTHERS COMPANY
1849 Columbus Road
Cleveland 13, Ohio

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THE A. F. HOLDEN COMPANY
14341 Schaefer Highway
Detroit 27, Michigan

FURNACES (Vacuum)

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IPSEN INDUSTRIES, INC.
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Chicago 12, Illinois
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Toledo, Ohio

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ARMOUR AND COMPANY
AMMONIA DIVISION
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Chicago, Illinois
HAMLER INDUSTRIES, INC.
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Chicago 38, Illinois

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METAL CHEMICALS SECTION
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New York 20, New York
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Dearborn, Michigan

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HEAT TREATING EQUIPMENT

The new **STANWOOD** Cor-Wal Construction in Stacking Baskets

No. 355

Following exhaustive tests, Stanwood offers the new Cor-Wal construction Stacking Baskets. Sides of this heat resistant alloy basket are corrugated rolled metal, imparting a longer service life, greater load carrying ability and lighter weight. Bottom grid, grid supporting base ring and stacking ring at top are high temperature cast alloy. Use Stanwood's broad experience and modern facilities for your heat treating equipment—baskets, trays, fixtures, retorts, pots, carburizing boxes and furnace parts. Send for catalog. Stanwood Corporation, 4825 West Cortland Street, Chicago, 39, Illinois.

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